SCIENTIFIC AMERICAN

The Monthly Journal of Practical Information

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DETERMINING SIXTEEN BRANDS OF AUTOMOBILE PERFORMANCE ON THE ROAD.—[See page 162.]

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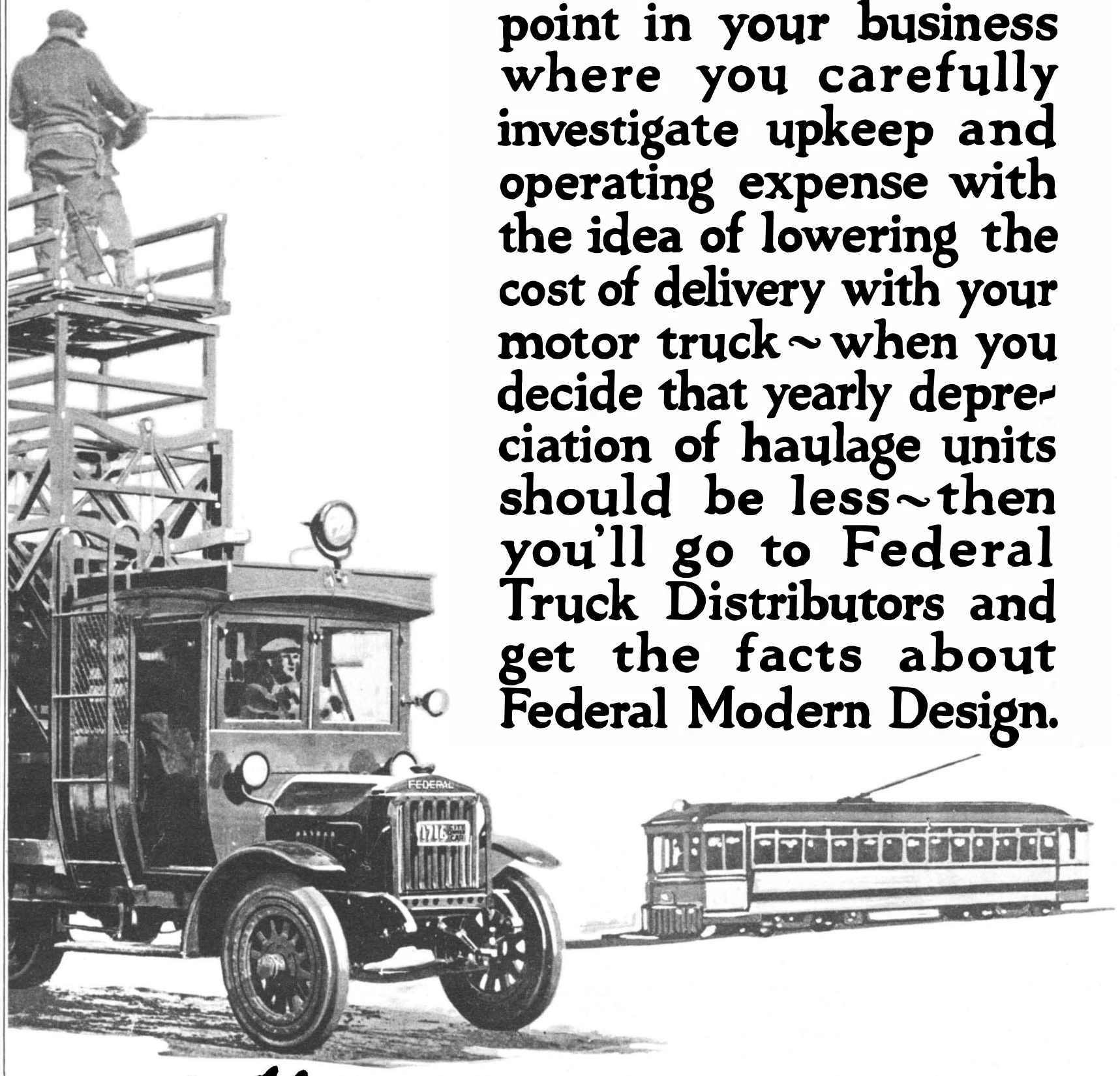

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With the Editors

"YOU have sixteen ohms of malaria," exclaimed the man at the rheostat handles to a member of the SCIENTIFIC AMERICAN editorial staff, who has been investigating in a preliminary way the intricacies of the much-disputed electronic Reactions of Abrams. Never has a subject attracted so much attention in and out of medical circles as this new method of diagnosis and treatment developed by Dr. Albert Abrams of San Francisco. The "ERA," as the Electronic Reactions of Abrams method is termed for short, has its staunch advocates. There are "ERA" practitioners throughout the country. Remarkable cures are said to be effected through this latest therapeutic agency, and there are a number of apparently well-authenticated cases of cancer cures. But, on the other hand, there are many, many doubters in and out of medical circles. Attack after attack has been delivered against "ERA." Still, the matter remains an unsettled controversy. The public, looking on, remains in a quandry.

EVERYWHERE, throughout this country, one hears the pointed question: "How about the Abrams electronic reactions?" We receive letter after letter asking us for our opinion regarding what, sooner or later, must prove to be the dawn of a new era in medicine, or a rank fraud which has assumed serious proportions. A member of our staff recently toured the Middle West and came in contact with numerous men in divers fields—writers, editors of magazines, journalists, advertising men, manufacturers, salesmen, mechanical engineers, and so on. The topic of conversation which never failed to arouse the greatest response was Dr. Abrams and his electronic reactions. And why not? After all is said and done, our greatest concern, no matter what may be our life's work, is the welfare of our body. Anything which tends to make us better men must receive prime consideration.

JUST as we committed ourselves to an investigation of psychic phenomena, which has now been under way for many months, so we are going to undertake an investigation of the Electronic Reactions of Abrams. Frankly, it is a very difficult task, requiring almost no end of research in the field and in the laboratory. We shall invite the advocates of "ERA" to present their side of the case. Already, our preliminary work has been greatly facilitated by the hearty cooperation of an Abrams practitioner in New York City. We shall invite the medical fraternity to aid us in our investigation in a broad and unbiased spirit, quite in keeping with our own open-minded attitude. Numerous tests will be made, and the results reported to you in due course. But—and this is a point for you to remember—do not expect an immediate solution of the Abrams mystery. It is going to require much time in order that the investigation may be worthy of its sponsors. In the October issue we hope to have something to tell you regarding some preliminary impressions of the Abrams method.

ONE of our regular correspondents has been spending several weeks in Washington, going over reams of reports and statistics. He is now down South, looking into the big projects in the planning and in the building, for that vast territory which is rapidly developing along industrial lines. This correspondent is working on the subject of water power; he is seeking the leading opinions of the nation; he is delving deep into our water resources. His first article will appear in an early issue, and will be followed by others so as to develop a complete survey of the water-power situation and its future. This series on water power will be a feature of a virile campaign for cheaper power involving, for the most part, the vast potentialities of our water resources, but also dealing with coals and lignites and oils and other power producers. Cheaper power remains the very backbone of industrial life, not to mention its important rôle in the American home.

FROM the article entitled "A Small Private Laboratory," appearing elsewhere in this issue, something may be learned regarding the remarkable Riverbank Laboratories. The member of our staff who visited the laboratories and was treated to a veritable surprise party, returned with a goodly supply of data and photographs from Riverbank. The present story is a general account of the Riverbank Laboratories, so it remains for subsequent issues to tell you in detail of some of the interesting investigations now being conducted there. Most important of all, however, our visit has served to establish pleasant relations with Riverbank, so that we may keep in touch with developments in the future.

RECENT progress in aeronautics has been almost bewildering in its extent and variety. The world's speed record now stands at nearly 245 miles per hour. Awe-inspiring endurance records and a non-stop coast-to-coast flight are likewise to the credit of our Army Air Service. Engines on full-power tests are now expected to run 250 hours continuously. Gliders remain aloft for many hours with nothing but air currents and the skill of their pilots to sustain them. Helicopters have risen vertically, hovered over a given point, made complete circuits in horizontal flight. Airplanes have been attached to dirigibles while both types of aircraft were in rapid flight. Metal is displacing wood in the construction of airplanes. Pilotless planes carry out complicated evolutions. These and many other remarkable features mark the rapid progress of aeronautics; and, rather than deal with each feature by itself, we have thought it best to review the recent progress of the art in one essay, in order that each feature could be given its proper standing and place in the whole scheme of aeronautics. Our review of progress in aeronautics will appear in our October and November issues. It has been prepared by Alexander Klemin, well-known lecturer in aeronautics at New York University.

SMASHING dishes to learn how to make better dishes; how water power has paid for the paving of a town's streets; why armored suit inventors leave home; the latest developments in man-made lightning; recent ambitious undertakings in concrete construction; what happens when wood shrinks; how fabrics are waterproofed; the poisonous plants of the usual garden; ingenious uses of the welding torch; the energy of the atoms and the possibilities of applying a harness; the story behind the Underwriters Laboratories label; how our automobile fuel is brought to us—these are but a few of the subjects which will serve to make the October issue of the SCIENTIFIC AMERICAN more interesting than ever.

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SEVENTY-NINTH YEAR

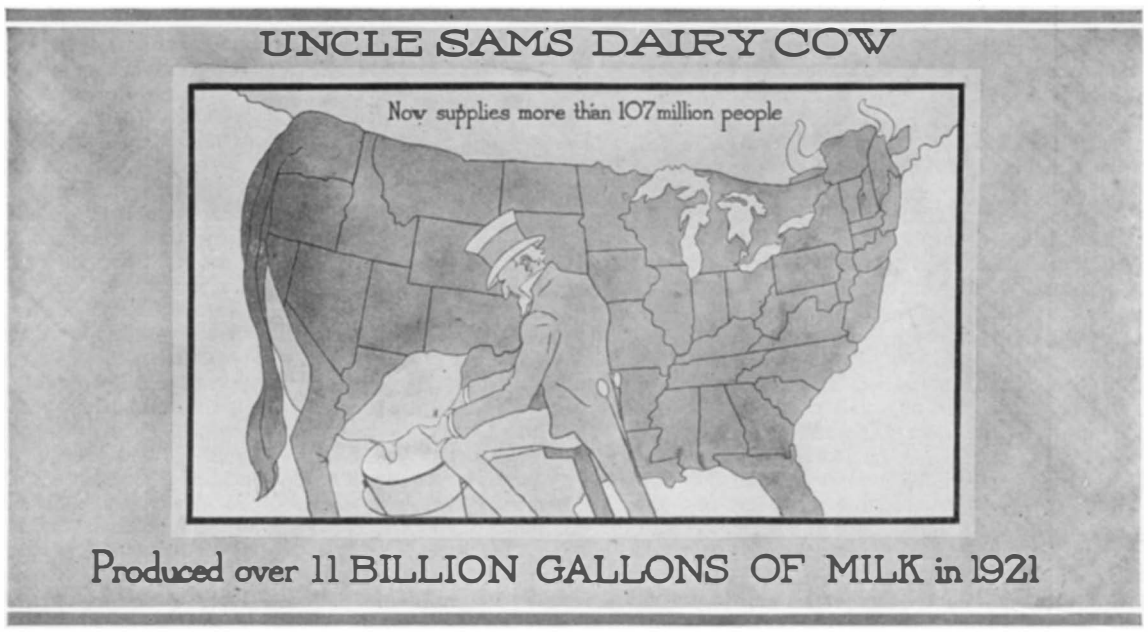
SCIENTIFIC AMERICAN

THE MONTHLY JOURNAL OF PRACTICAL INFORMATION

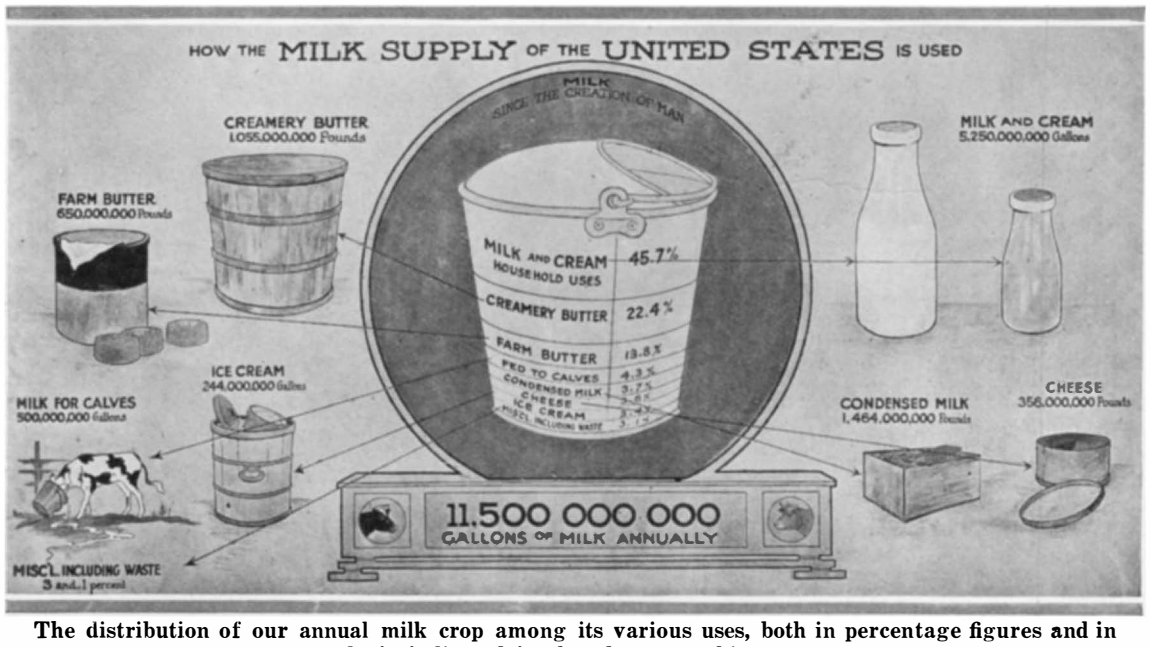
NEW YORK, SEPTEMBER, 1923

A Nation of Milk Producers and Users

THE United States is a wheat-producing country, par excellence; yet the value in 1922 of our entire wheat crop is but one-third that of the dairy products—milk and cream, butter, cheese, and the other things that come out of the milk pail. Cotton has been king, and will be again, if he is not actually on the throne at the moment; but the fleecy staple produced on all our farms is worth barely half as much as the output of all our cows. If we add into a single item the potato, oats and tobacco crops, they will total only a little bit more in value than milk and milk products. We are the greatest live-stock nation in the world; yet if we were to bring into the market for slaughter and sale every beef animal, every lamb and sheep and every hog in the United States, we should find that the proceeds would not pay for the dairy products of a year. The dairy products are produced without destroying the dairy cows, who go right ahead next year as last; and the procedure suggested would wipe out the meat herds. That is to say, the output of the milk industry is equal to the entire capital stock in trade of the meat industry!



The figures bear out the cartoonist's idea of what the cow means to the United States



The distribution of our annual milk crop among its various uses, both in percentage figures and in pounds, is indicated in the above graphic statement

Dairy cattle in the United States number approximately 30,000,000 head. They are found on approximately 4,500,000 farms—70 per cent of our agricultural establishments including milk among their crops. On the farm, milk and milk products for 1922 were valued at $2,090,450,000; by the time they had reached the ultimate consumer they were worth more than three billions.

Our drawing shows sufficiently the distribution of this immense total, save that it does not indicate what is left for inclusion in the "miscellaneous" item. This goes into the manufacture of milk powder, malted milk, and other minor commodities, and allows also for the wastage and losses incident to manufacturing processes.

We have in operation—or had when the census man went his rounds—3885 creameries, 2838 cheese factories, 553 condensed milk establishments, and uncounted thousands of concerns engaged in the distribution of milk, the manufacture of ice cream, and in other collateral aspects of the dairy industry.

The average milk production of 25,000,000 cows that are being milked in the United States today is 4021 pounds per year. As showing what breeding will do, many animals yield 10,000 pounds, a number 20,000, and a select few 30,000 or more. The Department of Agriculture, making due concession to the obvious fact that every farmer cannot have a herd of prize cows, believes that due attention to feeding and breeding would double the national average.

A simple division of 11,900,000,000 gallons by 108,000,000 people will indicate that we produce 100 gallons of milk for each man, woman and child. Of this, we drink seven gallons more per capita than we did in 1914. Our city dwellers drink, or use otherwise on their tables, an average of a pint of milk per capita per day. The individual ration of butter throughout the country was 16 pounds for the year, and any reader who did not eat 2¼ gallons of ice cream in 1921 was not getting his fair share. Our annual consumption of cheese, as might be expected, is far below that of many European countries, coming to only 3.7 pounds per capita. If we ate cheese with the Danes, English, Dutch, French or Germans, we should have a market for nine billion pounds of milk beyond our present mark.

Wisconsin is the premier dairying State, having maintained the position since 1920. On January 1, 1923, there were 2,195,000 milch cows in this State. New York and Minnesota came next, with 1,678,000 and 1,641,000, respectively. Illinois, Iowa, Pennsylvania, Ohio and Texas also have each more than a million cows in milk production.

Speaking of the condensed milk end of our dairy industry, it is of interest to learn that the annual output of cans, placed end to end, would encircle the globe not quite five times. To fill these cans requires the milk of over 900,000 cows. A year's production of canned milk, packed in cases, would duplicate the pyramid of Cheops, which measures 495 feet from the base to the peak. A train 499 miles long would be needed to haul at one time a year's output of condensed milk. One year's output of condensed milk represented 2,031,000,000 pounds in the can, and 4,504,000,000 pounds in the raw milk state. Condensed milk contains 30 per cent milk solids, 30 per cent water, and 40 per cent cane sugar.

Evaporated milk is unsweetened milk, the reduction in bulk being obtained by the elimination of much of the original water content.

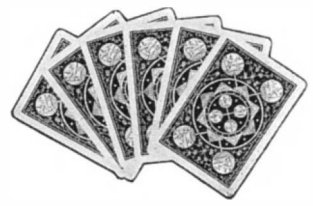
It is said that through the condensing and evaporating of milk we are saving in freight handling some 1,200,000 tons annually. Not only in reduced freight costs but in other ways the condensing and evaporating of milk has proved a great boon. In many parts of our country, particularly the South, milk is not obtainable in the fresh state and reliance must, in part, be placed on canned milk, which thus becomes an indispensable feature of the diet rather than an emergency measure.

The symbolic Uncle Sam has been represented as serving in many capacities—guardian of the treasury, soldier, diplomat, agriculturalist, postal official, naval officer, and so on. This distinguished personage, it appears from the above figures, might better be shown with an apron over his clothes and a milk can in his hand. Of a truth, the philosopher was right who remarked that the human animal is a parasite upon the cow.

The Inventor and the Gay Gambler

Ingenuity Ranging from Marked Cards to Crooked Roulette Wheels for Separating the Fool and His Money

By Edward H. Smith



IN THE misty prehistory of India there lived one Raja Yudhishthira, a first-class gambling man. He is the Odysseus of the Mahabharata, that great epic whose principal parts probably date half a thousand years before Jesus. His was the Pandava family, constantly at war with the cousin, Kauravas. I cite from Wheeler's translation of the poem:

"And it came to pass that Duryodhana (chief of the enemies) was very jealous of the triumph that his cousin, Yudhishthira, had performed, and he desired in his heart to destroy the Pandavas and gain possession of their raj. Now Sakuni was the brother of Gandhari, who was the mother of the Kauravas; and he was very skilful in throwing dice and in playing with dice that were loaded; insomuch that whenever he played he always won the game. So Duryodhana plotted with his uncle that Yudhishthira should be invited to a match at gambling, and that Sakuni should challenge him to a game and win all his wealth and lands."

Yudhishthira lost all his wealth and lands and his kingdom, right enough. Worse yet, he staked the sacred polyandrous wife, Draupadi, against Sakuni's queer dice and lost her into the bargain. After many wanderings and adventures he, however, regained all and even reached the sunlit heights—so that a gambler evidently may enter the kingdom of heaven.

Yet this is hardly the point. What is worth noting is the fact that in the day of Cyrus, Buddha, Nebuchadnezzar, Crœsus, the first Mikado, Pisistratus, the last Tarquin and the first Roman consuls, and other such far-off worthies, someone had invented crooked implements for the gaming table; yea, probably long before! Thus the gambler-inventor, though he rank not with the man who chipped the first flint hand ax or fashioned the stone skull crusher, is, nevertheless, one of the earliest improvisers of the instruments of civilization.

The disastrous dice of Yudhishthira were called *coupun*, and the modern gamester might have some difficulty deciding that they had not been made last week in Chicago. A number of these ancient and faithless cubes were thrown from the veritable box still in daily use or misuse. We know that the Romans dallied with the same perfidious *talus*, and any anthropologist will tell you that the darky's devotion to the galloping ivories may be partly the scurvy inculcation of the white man, but is at bottom the deep tradition of a similar instrument of treachery and glory, much used in savage Africa.

So, the first emotion that sweeps us when we think of the connection between invention and gambling, is a sinking of the heart at man's ancient and unregenerate roguery. Men were loading dice before they had dreamed of the globular earth; they had swords of steel while they were still ploughing with forked sticks. And rightly so, perhaps.

The uninitiate modern gentleman, when he travels in a Pullman compartment and plays a disastrous game of poker with affable strangers, is appalled when he discovers later that a pack of marked cards has been his undoing. Yet listen to George Devol, the famous old Mississippi River gambler, writing of an event before 1850:

"While waiting at Donelsville for a boat to take me to New Orleans, I fell in with a fellow who proposed a game of cards to pass the time until the boat arrived. We went into a saloon and sat down to play a game of poker. He brought out an old deck of marked cards, which I recognized the moment I saw them. We began to play. I knew the fellow took me for a sucker, so I let him play me with 'his cards' until I got a chance to down him, which I did, for all he had."

So, whether one look down the distant vistas of time or merely glance at the immediate past of our own country, the result is the same. We find the "fixed" gambling device in use everywhere. The inventor of such infernal stuff has been at work since the beginning. But more laughter or indignation kindles (according to temper) when we find that today the invention or devising of crooked implements of the game is an organized business; that large factories exist which turn out marked cards, loaded dice, fixed roulette wheels and many other such pretty instruments by the thousands. Once this is realized, we are not further disturbed to find that every experienced gambler marks his own cards, loads his own dice and contrives other "controls" of his weapons.

The interest, then, lies rather in what these inventors and improvers have achieved. It is a well-known principle of gaming that the nature of the trick must be varied from time to time, as the sucker becomes suspicious of or familiar with one fraud after the other. It is this fact that keeps the inventor and adapter ever at work. Since dice seem to be the most ancient and simple implements of play and cheating, we may as well see what has been done in this field.

All dice are fixed in one of two ways—dice used for the everlasting game of craps, I mean. Some are so corrupted that the advantage will lie with the player. These are commonly called passers or hitters. The others are arranged for the benefit of the banker or fader (whoever bets that the player will not make his point). These are known to the gentry as missouts, faders or banking dice. In almost every instance the same method used for making passers can be employed for producing missouts. It is merely a matter of causing opposite combinations of numbers to turn up. For instance, if the player can be sure that the numbers 4, 6, 8 and 10 will turn up almost invariably, he has a considerable percentage, since the fatal craps numbers 2, 3, 7, 11 and 12 will turn up less frequently. Of course, the player who uses such a set of "bones" gives up the advantage of occasional showings of the winning 7 and 11 on the first throw.

We need not go into the older methods of producing such results. Indeed, it is not necessary to give more than passing mention to the fact that transparent dice are now loaded with invisible bits of platinum behind the spots or that dice are now made which can be changed from passers to missouts by striking them against the table sharply in various manners, explained in the directions which the makers of these nefarious implements supply with each set sold. Mis-shaped, mis-spotted, adhesive or suction dice are all fairly well known and ingenious enough. But there are recent developments in this field to merit more careful attention.

Within the last three years one of the professional inventors of crooked dice has brought out what is called the capped die. I quote from his own description:

"In making these dice a cap or face of specially prepared material is permanently attached to certain sides of a blank die. This is done so cleverly that the joint is absolutely invisible, but the composition of this cap is such that a die so prepared will show a strong percentage when used on a billiard table or other hard substance of similar texture. These dice can be used where shaped (mis-shaped) or loaded dice would be detected immediately."

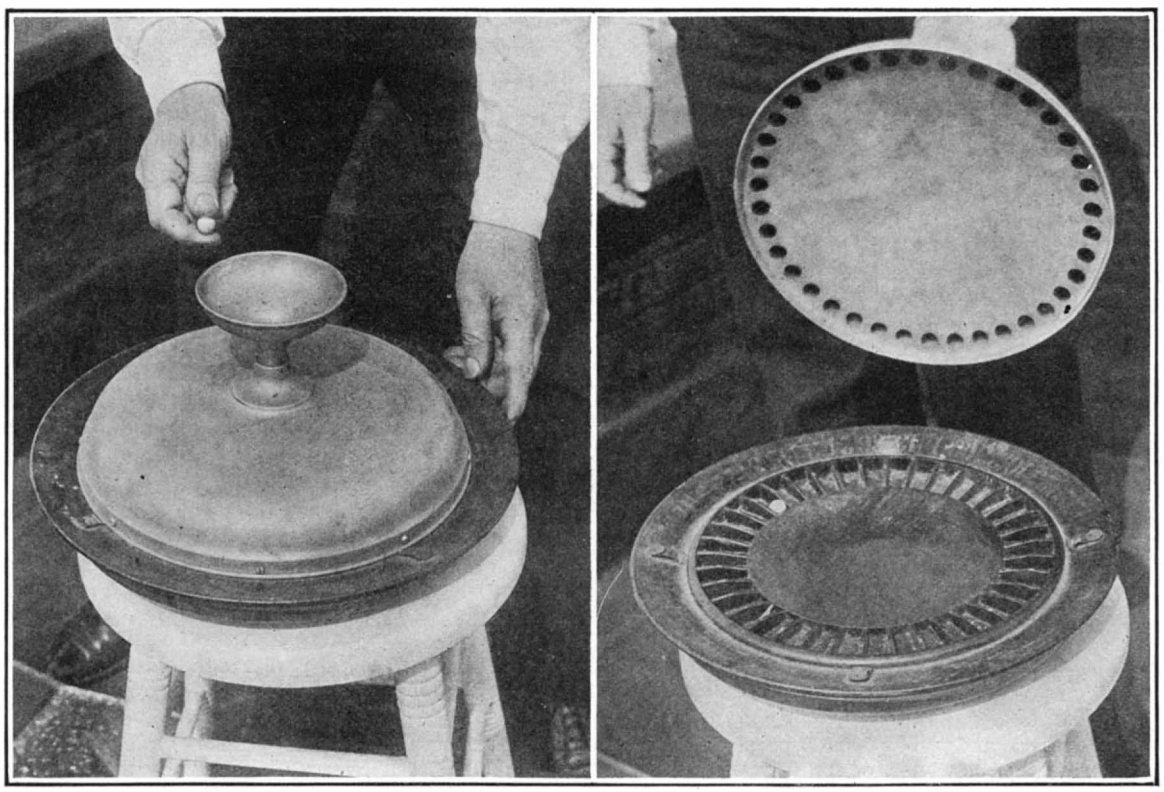
But the making of unfair or percentage dice long since passed out of the field of the merely physical and come under the purview of chemistry and electricity. Various kinds of celluloid dice are now made whose weight on certain faces can be definitely changed by the application of chemicals. I quote from the catalog of one of the big manufacturing firms:

"Our special magic liquid, when applied to transparent dice according to instructions, will afford the operator a handy and efficient method of making percentage dice. This liquid is compounded from our own formula and penetrates the faces of the dice to which it is applied, causing a change in the chemical composition of the celluloid. This results in bringing up the desired faces and gives the operator a good percentage. The work will last indefinitely."

I suspect, of course, that the magic liquid is nothing but a drop of acid, which actually does change the nature of the celluloid to which it is applied, making it weigh less. Thus, if I want the number 6 to turn up on a die, I touch that plane of the die with the acid, and lo, the job is done.

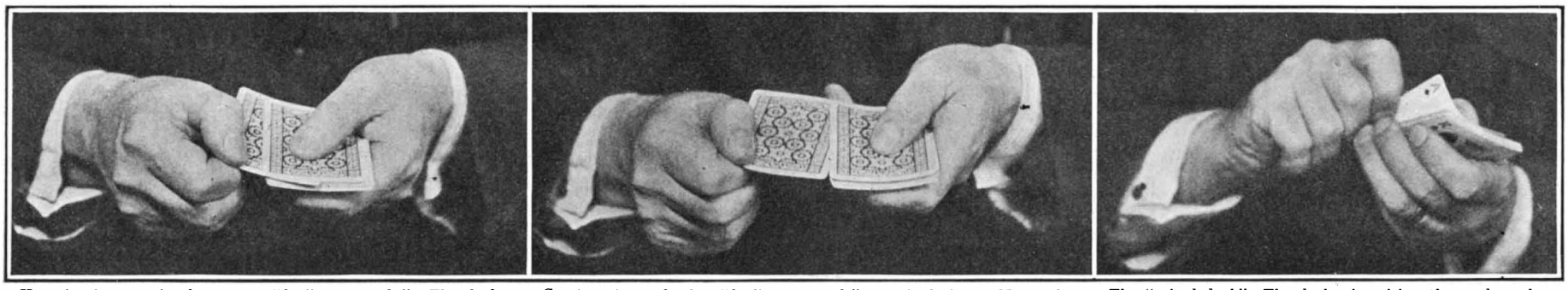
But the most intriguing of all these pleasant inventions for the swift division of the fool and his money is the magnetic money drawer or showcase humidor. Both work on the same principle, so it will be sufficient to describe the humidor, which seems most mysterious to the layman. This device is most used in cigar stores where much shaking for cigars or money goes on. Its siren charm is based on a common misconception. Everyone had been told that glass is a non-conductor, against which electricity has no power. Naturally, no one but the technician believes that dice can be controlled through the top of a thick glass plate by electric means. The secret lies in the difference between electric current and magnetism.

Accordingly, an electro-magnet, enclosed in a box which looks like a humidor, is placed in the show case, surrounded with the usual array of cigar boxes. Some are even arranged with a



Left: The victim believes that because this roulette wheel is covered and the dealer cannot see the ball or the numbers when spinning, there can be no cheating. He does not know, however, that the lid that is supposed to protect him actually betrays him. The dealer is about to spin the ball into the funnel top of the lid. When it descends, however, it runs through a tube and invariably comes out at the same spot, just under the screw with the perpendicular cut. *Right:* The same roulette wheel with the lid lifted. It had been set at 22, and the ball is in that slot

Covering the roulette wheel by no means protects the player



Here is the practice known as "dealing seconds." The dealer has slipped back the top card slightly, to get at the one beneath, and to retain the top card

Continuation of the "dealing seconds" manipulation. Here the dealer is seen pulling out the "second." This is done with extreme rapidity and is generally not detected

The "raised deal." The dealer is raising the cards as he passes them out, so that his partner directly opposite may see what goes into every hand

Some tricks of the crooked dealer which take card playing out of the games-of-chance category

layer of fancy-sized cigars just under the box lid, in case any curious customer or dice player might ask to be shown. This magnet derives its power either from a series of dry cells or from a connection with the lighting circuit, the latter being the final refinement. The magnet is, of course, so raised that it is directly under the glass top and magnetizes a field perhaps 6 x 6 or 8 x 8 inches in dimensions.

The rest consists of a foot-lever switch and a set of electro-magnetic dice. The keeper of the cigar store stands in such position that he always dumps his dice on the magnetized field and naturally throws the high and winning faces. The moment his opponent throws, however, the dishonest merchant lifts the foot switch and the field is no longer magnetized. The percentage in favor of the man at the switch is very great. Nobody but a professional gambler is likely to suspect the device and such worthies are unwelcome intruders in dens of this sort.

Cheating at cards is a subject for long and scholarly investigation. Probably their marking originated with the Chinese who invented them, many centuries before they reached Europe. Speaking broadly, there are two methods of crooking cards—marking their backs so that the keen-eyed gambler knows what every player holds, and trimming the edges in various ways to assist in crooked dealing. Marked cards are called readers; those trimmed at the edges come under the general classification of strippers, though some are not trimmed for stripping but for high and low cutting. These terms will hardly need explanation among card players.

Marked cards can be and are being made in scores of ways. There are, first of all, the ready-made readers which can be bought from the same manufacturers who turn out the crooked dice devices. They are made up in an almost infinite variety of patterns with almost invisible markings, such as a slight dimming or darkening of a line or figure at certain places, to indicate, aces, kings, queens, jacks and tens, the important cards for poker. But the cleverest gamblers usually shun these patent readers for the reason that the next man may be as familiar with them as the gamester himself. Accordingly, the gentry make their own readers in many ingenious ways. A pointed piece of spermacetti, wax or resinous pine, drawn across the back of a card will leave a glossy trail which can only be seen when facing a strong light. The gambler sees to it that he is placed to see. Coating the edge of a finger or thumb nail with India ink enables the gamester to mark important cards at the edges while he is playing. Sand, glass, emery, resin and acids are used to remove the glossy finish from certain portions of a card's back, and the sensitized fingers of the gambler then reveal what he is giving to this man and that while he deals. When he comes to a desirable card he holds it on top and deals the next card underneath by a very simple sleight-of-hand trick. His partner or he himself gets the good card and the next good one. In this manner he fills up hands for himself or his confederate.

Other ingenious ways of marking are by a fine pricking of cards near the edge by means of a finger ring on which is concealed this fine point or "peg"; daubing the cards along the edges with very slight finger prints of blue or red, according to the color of the deck in use, the color being got either from soft red and blue pencils or from tiny pillboxes of color in the opposite vest pockets; touching spots on the back of cards with volatile oils which darken the backs at the given points long enough to make them readable for the period of the game but disappear later through evaporation; touching the edges of cards at fixed points with a strong solution of gum Arabic, and many other methods.

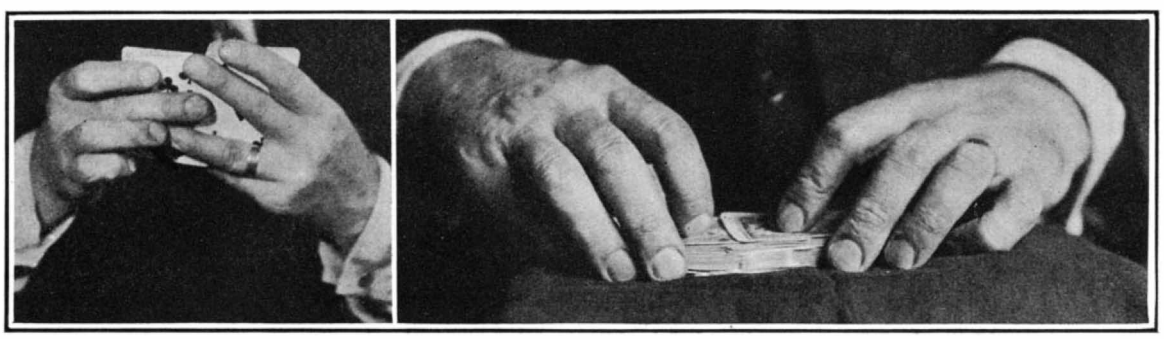
But playing with marked cards is only the beginning of the roguery which has been applied to this antique pastime. The inventions used are almost as numerous as the fools who play for stakes.

Little mirrors or "shiners" cunningly affixed to a pipe which the gambler lays down on the table as he deals, or attached to a box of matches or to the table itself, enable him to see the faces of the cards as he slips them off, one by one, in dealing. Such tricks are old. The inventor of recent years has devoted himself mostly to the card holdout machines, of which there is a staggering variety. Everyone remembers the gambler who slipped an ace up his sleeve. But supposing you have this man outfitted with a concealed mechanism which takes the aces up his sleeve, into his vest pocket or into the vest or shirt front with magic swiftness and silence. Suppose such a machine is capable of passing down into the concealed hand of the gambler a "cold" deck exactly like the one with which you have been playing, at the same time taking the true deck up the other sleeve out of the other hand of the evil magician. Must I explain that a cold deck is one that has been stacked so that the cards will fall in a fixed order, giving the sucker a big hand but the gambler a still better one?

Such mechanisms are known by various names which usually indicate their manner of operation. There are arm pressure holdouts, which operate by pressing the arm against a rubber bag concealed in the sleeve. Pressing the bag sends the hand of the holdout machine down the sleeve to grip or give up the desired card. This hand is always an ordinary steel clip, such as may be commonly seen in offices where large stacks of papers are to be held together. There is also the knee-spread holdout. This is worked by means of cords concealed under the clothing and issuing through small vents in the trouser legs at the knees, where they connect. By spreading the knees a little the mechanism in the sleeves pushes down to receive or release the cards or the cold deck. Again we have the chest expansion or breast holdout machine, which is motivated by inflating and deflating the lungs. These machines are always operated by a gambler who wears his coat, which may be marked for its long and loose sleeves. Accordingly, many partly informed men refuse to play in a game unless all remove their coats.

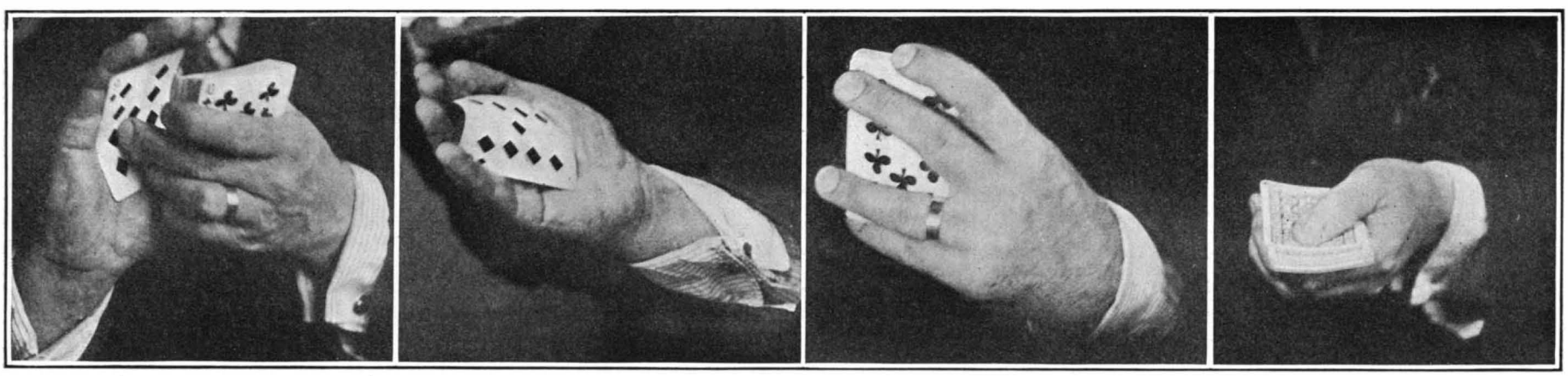
But here again a little wisdom is a dangerous thing. The inventors who serve the gambler have in recent years devised a holdout machine which required no coat or long sleeves. Here is the official description by its inventor and maker:

(*Continued on page 215*)



Left: Dealing from the bottom. The dealer does not hold the deck in this position in practice, but keeps the faces down. In the illustration he is holding the deck up to show the manner in which a ten of clubs is got from the bottom, again with extreme rapidity. *Right:* "Dealing strippers." The high cards are wide at one end and the low cards are narrow, so that the dealer can strip out all the desirable cards by pulling the deck apart with the fingers along the edges, as shown

Dealing from the bottom and dealing strippers



Palming a card. The deck is held so that the top card may be slipped into the palm of the hand with the right thumb

The card held in the palm in a natural and positive manner. The crooked gambler uses this hand freely, without arousing suspicion

Another instance of bottom dealing. The dealer is holding the deck in a suitable manner to facilitate bottom dealing at his convenience

One should always be suspicious of the dealer who moves back the top card. It is the first step in "dealing seconds"

How the dextrous hands of the crooked gambler serve him to good stead

United States Forest Service Map at Overland Park, Denver

Camps of the Central Circle

Recognition Given the Automobile Tourist by Mid-Western Municipalities

By Avis Gordon Vestal

THOUSANDS of families will "vacate" this summer—and in future summers—by following blazed highways in motor cars bulging with camp equipment. For each portable canvas home there will be waiting, in a choice of cities, free leaseholds of land for a "one-night stand," or even for a restful visit of several weeks. From the Great Lakes to the majestic peaks of the western Continental Divide municipal hospitalities of a surprising number are prepared. Toward sunset the tourist can begin to look for some "latch-string hanging out"—a placard posted by the path, inviting him and his to use the town's free camp-site.

Only a decade ago motor cars were of much less general ownership. Few users had driven across as many as three states in continuous journey. Highways then offered much less comfort to "mo-tourists" bumping over them, choked with dust, wallowing in mud, or straying from the intended way. In the fall of 1913 the Lincoln Highway Association was organized. In several succeeding seasons it was mapped, marked, and motored over. Crossing the continent in a "gasoline carriage," once a great adventure, became a safe and comfortable pleasure trip.

The public must have been ripe for this, for the idea spread rapidly, and other transcontinental highways were soon named, financed, improved, and blazed by brightly painted poles. From east coast to western water a choice of many paths may now be had. Numerous also are the ribbons of road intersecting our country quite from north to south, connecting Canada with the Gulf via the Mississippi Valley states. To this legion of possible paths may be added the routes of trans-state extent, marked by the cooperative efforts of groups of local highway organizations, or, as in Iowa and Wisconsin, by the authority of state highway officials. What are bettered roads and marked ones for, but to be followed far?

Along the ready roads rolled first the motor cars of the well-to-do, with paid chauffeurs and no dunnage except suitcases or expensive runningboard trunks filled with formal clothes. For the three "b's"—bath, board, and bed—hotels were patronized. It was early discovered that in some cities arriving guests would find the excellent hotel accommodations all bespoken. If nighttime chanced to bring them to some small town they would find only short-order restaurants, with food worse than indifferently cooked, and lodging houses far from meeting the familiar comfort standards. Still farther west, in the sparsely settled portions of the high plains and mountains, there were apt to come hungry times and sleepy hours when no towns of any kind were discoverable. The writer once rode 125 miles in eastern Wyoming, on the Chicago, Black Hills and Yellowstone Highway and found but one tiny village in all that stretch, while ranch houses might be fifteen to twenty miles apart. The remedy was to carry a minimum of food, camp equipment, and water for emergency use.

Just such a taste of seeing a wide country by riding over a certain and comfortable course, lunching in a grove, camping under the stars, and the idea of planning deliberately for camp life all the way grew like a snowball rolled across the lawn in melting weather. Demand and supply met. Purchasable camp equipment was soon improved to meet the limitations of motor portability and to fill all the varied needs of a comfortable "home away from home." A complete outfit could be purchased in one unit, as in the camp trailer, or an outfit could be assembled from a splendid assortment of separate units, from bed to stove, from bucket to refrigerator. The camp phase of motor touring had risen from an emergency necessity to joyful acceptance as a mode of life for the entire trip. "Motor-gypsying" became a recognized part of the "back-to-Nature" movement. And from the cost and kind of many motor cars now carrying full camp equipment it is apparent that many relatively rich roamers have deserted the hotels. Beside them come motorists from the great middle class and the great middle states. Even more in evidence are the numerous "flivvers," with five to seven persons, a dog, and a silhouette like a moving van.

The municipal camp was the next logical step. Not for long did the tourist Meccas along the Rockies look askance at the visitors not putting up in hotels. It was soon apparent that these were decent, law-abiding folk—prosperous farmers, substantial bankers, oil magnates from the southwest, reputable physicians from Iowa, school teachers from Illinois, Missouri merchants with a good rating—all with coin of the realm in the pockets of their khaki. Far-sighted boosters saw the drift—and established free municipal camp-sites. By 1916 a number of Colorado cities were offering such hospitality, as were a few other towns in the scenic parts of other states popular for vacations.

But the *central states?* Tourists had been hurrying through them, pitching tents by the roadsides. There was no invitation to "stop and shop." By 1917 a few towns began to *permit* camping in some public vacant place, but seldom was any provision made for comfort or to encourage lingering. But the close of the war saw a great boom in the establishment of municipal campsites by the cities of the central plains. Many of the residents of these states had themselves tasted the joys of nomad life and brought back inspiration from the host camps they had visited in the mountains. The last five years a rapidly increasing number of host towns have been gathering guests from the highways and byways by posting invitations at their city limits, or even many miles beyond on the main roads.

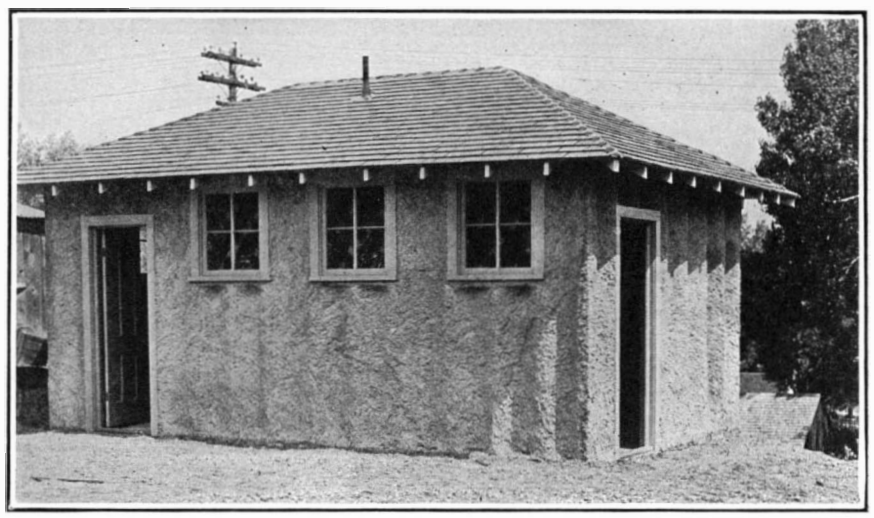
The usual evolution begins with the tentative opening of some vacant lots at the edge of town or with the corner of an existing park. If no shade exists, trees are planted and watered. If the site chosen is beyond the community conveniences, or if the little town lacks them, wells are sunk and sanitation provided. Within a season or two the invitation boards along the roads are supplemented, in some cases, by neat printed folders distributed through garages or by the Chambers of Commerce. These give the location of the camp, what comforts it offers, what points of interest may be visited, what recreation facilities are offered. The attractions may finally come to include some—in the very largest camps perhaps all—of the following: free fuel, usually wood, but sometimes gas or electricity; fireplaces or stoves; lights; running water, sometimes with special provision for washing cars; shade; shelter for cooking center; comfort stations with modern plumbing—which may include shower baths and laundry tubs, occasionally even a washing machine and electric flatiron; portable or permanent tables and benches. Sometimes a general store is set up near by or the local establishments extend service to the grounds.

To induce transients to stay over, recreation is being increasingly developed. The things established for local residents are shared and often added to. Playground apparatus; boating, bathing, swimming, or fishing; golf, tennis, or baseball; in the larger cities, visiting the museum, zoo, or music centers; dancing; visiting nearby points of historic or scenic interest.

The forces most active in establishing these camps are: local divisions of the big highway associations; Chambers of Commerce; garage men and dealers in automobiles and accessories; civic clubs; park boards; women's societies; boy scouts; campfire girls. The point of view may often be "enlightened selfishness," but results are worthy of the efforts so liberally expended.

Where only existing comforts are offered upon grounds already provided with park caretakers the additional cost is not great. When utilities are added to improve the grounds the cost is sometimes borne by city tax funds apportioned for park development. More often, however, the additions that are made and extra labor required are paid for by organized private interests, such as the Commercial Club or Automobile Club.

Fireplace in a public camp at St. Louis, being put to good use by automobile tourists



Comfort station in the public camping ground at Canon City, Col.

Electric light, running water, fireplaces, shower baths and free wood are among the things provided at the municipal camping ground in Pueblo, Col.

The merchants derive benefits which compensate them. A camp does often help to "put a town on the map," and occasionally visitors decide to become residents, while the guests at a camp often spend considerable sums in the town.

Space does not permit consideration of the camps of the entire country, and as those east of the Alleghenies are few, while those west of the Rockies are better known, we have limited ourselves to the central states *through which* motorists used to pass on their way to mountain or seashore, but *in which* they may now find lingering a pleasure. With Ft. Riley, Kansas, approximately the geographical center of the country, as a hub, with a radius of about 500 miles, we can draw a central circle which includes all of portions of twenty states of the Mississippi Valley, reaching up the high plains and touching the Rocky Mountain region. The following list of camps is located in this circle. Under each state heading the parts numbered (1) were obtained through questionnaires sent to the Commercial Clubs of two hundred towns, or camps personally enjoyed by the writer; while the parts numbered (2) were obtained from newspaper clippings, from people who had visited the places named, or from the literature of highway associations. The list as a whole cannot pretend to be exhaustive, as the number of such camp-sites is constantly increasing:

Wisconsin: (1) Eau Claire, Madison; (2) Abbotsford, Alma Center, Amherst Junction, Augusta, Baldwin, Baraboo, Berlin, Birchwood, Black River Falls, Cambridge, Cazenovia, Chippewa Falls, Clayton, Columbus, Durand, Fall River, Fennimore, Frederic, Hudson, Hustler, Kilbourn, LaFarge, Luck, Marshfield, Mazomanie, Menominee, Merrimac, Milladore, Nekoosa, Pepin, Portage, Port Edwards, Rice Lake, Richland Center, Sparta, Spring Green, Spring Valley, Waterloo, Wilson, Wonewoc.

Illinois: (1) Decatur, Dekalb, Fulton, Medora, Peoria, Wilmington; (2) Dixon, Ottawa, Springfield.

Indiana, Kentucky, Tennessee: No camps reported within limits set.

Minnesota: (1) Austin, Bowlus, Breckenridge, Fergus Falls, Long Prairie, Mankato, Minneapolis, Montevideo, Red Wing, Rochester, St. Paul, Wells.

Iowa: (1) Charles City, Clarksville, Clinton, Council Bluffs, Des Moines, Iowa City, Keokuk, Lake Mills, Lyons, Marble Rock, Marion, Mason City, Mt. Pleasant, Sioux City, Tama, Ventura; (2) Akron, Chatsworth, Davis City, Hawarden, La Porte City, Little Sioux, Missouri Valley, Mondamin, Northwood, Onowa, Salix, Sloan, Westfield, Whiting.

Missouri: Brookfield, Hannibal, Kansas City, St. Joseph, St. Louis; (2) Bloomfield, Breckenridge, Cameron, Carthage, DeSoto, Farmington, LaClede, Macon, Osborn, Poplar Bluff, Sikeston.

Arkansas: (1) Marion.

Louisiana: (1) Shreveport.

North Dakota: No camps reported within circle limits.

South Dakota: (1) Deadwood, Mitchell, Rapid City, Spearfish, Sturgis; (2) Aberdeen, Alexandria, Bridgewater, Canton, Chamberlin, Cottonwood, Custer, Emery, Fairview, Hot Springs, Hudson, Huron, Kadoka, Kennebec, Kimball, Lead, Mt. Vernon, Murdo, New Underwood, Oakoma, Piedmont, Plankinton, Presho, Pukwana, Quinn, Reliance, Sioux Falls, Vivian, Wall, Wasta, White Lake, Whitewood.

Nebraska: (1) Chappell, Columbus, Cozad, Fremont, Gibbon, Gothenburg, Grand Island, Kearney, Lexington, Lincoln, North Platte, Omaha, Sidney; (2) Central City, Elm Creek, Valley.

Kansas: (1) Abilene, Baxter Springs, Coffeyville, Ellsworth, Garden City, Hiawatha, Highland, Larned, McPherson, Manhattan, Marion, Pittsburg, Salina, Wamego, Wichita, Winfield; (2) Dodge City, Great Bend, Hutchinson, Junction City, Lyons, Newton.

Oklahoma: (1) Guthrie, Miami, Oklahoma City; (2) Clinton, Granite, Shawnee.

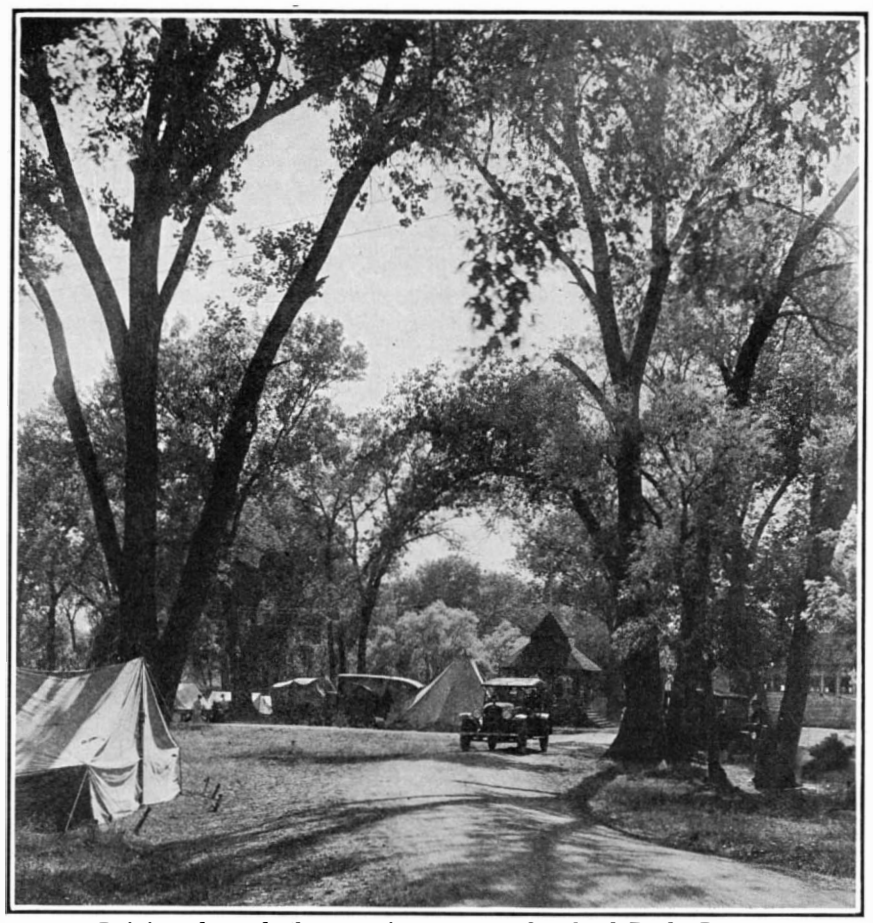
Texas: (1) Denison, Ft. Worth; (2) Wichita Falls.

Wyoming: (1) Cheyenne; (2) Douglas, Laramie, Lusk, Sundance, Torrington, Wheatland.

Colorado: (1) Boulder, Canon City, Colorado Springs, Denver, Florence, Ft. Collins, Greeley, Longmont, Platteville, Pueblo, Rocky Ford; (2) Berthoud, Blanca, Buena Vista, Burlington, Cripple Creek, Del Norte, Holly, Lamar, Las Animas, Leadville, Limon, Loveland, Olney Springs, Salida, Sheridan Lake, Sterling, Trinidad, Victor, Wellington, Westcliffe, Wetmore.

New Mexico: (1) Las Vegas, Raton.

Thus the automobile tourist is assured of camping space along his route through the central states, and, ultimately, in all states.



Driving through the camping area at Overland Park, Denver

Schoolroom Ventilation

THAT a well-designed but simple arrangement of window ventilation is the most promising method for classroom ventilation is the striking conclusion reached by the New York State Commission on Ventilation.

The commission made a careful experimental study of the effects of atmospheric conditions on health and efficiency, carried on in a specially constructed chamber in the College of the City of New York, and conducted a practical survey of the ventilating systems in use in the schools of Springfield, Mass., New York City, Minneapolis and other cities.

The commission found that, while window ventilated rooms have less complete air change than fan ventilated rooms, this reduced flushing was not objectionable. It was found sufficient to suppress the accumulation of odors and it permitted the maintenance of a cooler air condition, which the physiological and psychological experiments of the commission had shown was more favorable for comfort, health and efficiency. Furthermore, window ventilation did not tend to produce that uniformity of air currents and temperature characteristic of fan ventilated rooms which was found to exert a definitely harmful effect on health by promoting susceptibility to disease and affections of the air passages.

In schoolroom ventilation the commission emphasizes the need of careful temperature control, the temperature not to exceed 70 degrees, the use of window reflectors to prevent drafts, and adequate gravity exhaust ducts not less than eight square feet in diameter. The use of suction fans in the exhaust ducts was found to militate against the success of the system. The commission found that in the average classroom the most agreeable temperature was 67 degrees.

While well-devised and controlled systems of fan ventilation with windows closed were found capable of producing excellent results, certain characteristics inherent in this method made them definitely inferior to a good system of window ventilation. Where used, however, the commission found it necessary not only to have adequate provision of fan motor, duct and register equipment, but also to control mechanically and individually the temperature and volume of air supply in each room. — *Abstract from School and Society for January* 27, 1923.

Fighting the Corn Borer

MORE than 1,000,000 individuals of an important parasite of the European corn borer, *Habrobracon brevicornis* Wesmael, have been successfully reared and liberated in the densely infested area in New England. It was believed by entomologists of the United States Department of Agriculture that it might be worth while to attempt to introduce it into the badly infested areas of southern Ontario. Following a suggestion to this effect made to the Dominion entomologist, authorization was recently given by the Canadian government for an assistant for this purpose. This entomologist recently visited the laboratory at Arlington, Mass., to receive instruction in the technique necessary for handling the parasite.

"A Small Private Laboratory"

Some General Impressions Gathered During a Visit to the Riverbank Laboratories

By Austin C. Lescarboura, Mem. A.I.E.E.

FIVE HUNDRED AND FIFTY acres of rolling country overlooking the picturesque Fox River and dotted with various kinds and sizes of buildings; over one hundred contented men working with the zeal of the true scientist engaged in the work which lies closest to his heart; a vast array of all manner of scientific equipment in the hands of skilled technicians; a quiet, cheerful, healthful atmosphere conducive to creative activities; and last, but by no means least, time, time, and still more time that is so necessary in evolving answers to scientific problems which have long baffled an altogether too busy world—that, in brief, sums up the broad impression of how a remarkable man has realized a remarkable idea.

The locale of this story is that stretch of country between Batavia and Geneva in the State of Illinois, some forty miles out of Chicago. The remarkable man is Colonel George Fabyan. His remarkable idea, in fully materialized form, is known as the Riverbank Laboratories. And the reason why you have not heard of these things until now is due to the extreme modesty of Colonel Fabyan, who has always made it a point to do things rather than to talk about them.

Where Utility and Architecture Meet

On arriving at the Riverbank Laboratories, one is suddenly confronted by a group of odd buildings. Indeed, the immediate impression is that one is about to engage in a brand new kind of experience, and subsequent developments confirm that first impression. The buildings have apparently been constructed with but one thought in mind, namely, maximum utility. Conventional architecture has been cast aside. Particularly as regards one of the buildings, the bizarre feature consists of a step-like effect due to each successive floor being considerably smaller than the floor below it. In this manner the second floor is surrounded by a concrete terrace which is, in reality, the roof of a goodly portion of the ground floor, while the third floor is surrounded by a similar terrace which is the roof of the second floor, and so on. The general effect is not unlike the towering structures erected by children with their square wooden blocks.

The Colonel knew what he was about when he planned buildings of this terraced type. In the first place, the various floors have convenient terraces which may be reached by doors. Then, when it is in order to provide additional floor space on any floor, it is only necessary to build the necessary outside walls, as well as a concrete slab for the additional roofing, and the job is completed. Thus a laboratory building of this type keeps up with developments in much the same manner as the sectional bookcase idea.

Other Riverbank buildings are constructed with wings and towers and other irregularities, always with the paramount purpose of providing the maximum utility. The author does not happen to have a complete list of buildings, but it is certain that there are at least a dozen major laboratory buildings, together with bungalows and barns and garages and tool houses spread out over the vast tract of land.

So much for the buildings, externally speaking. Upon entering the first of these buildings, we are amazed at the vast array of equipment. Here is a mechanical laboratory equipped with lathes, drill presses, automatic saws, strength-testing machinery, and so on. We are conducted to a corner of a large room, where a curiously mounted electric motor, driving a countershaft by means of a leather belt and wooden pulleys, and surrounded by delicate testing devices, discloses a mechanical problem on the scientific operating table.

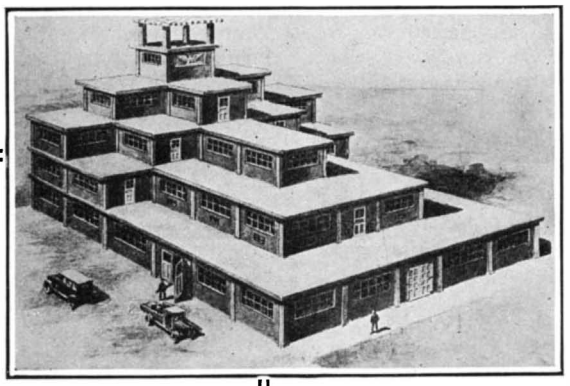
The problem proves to be a test on the relative wind friction resistance of open wooden pulleys with their spokes or webs exposed, and the same pulleys with disks that cover the spokes or webs and thus reduce the wind friction. Off-hand, even the most thoughtful among us would probably dismiss this wind friction possibility as being quite insignificant and not worth the bother of experimentation. But not so with Colonel Fabyan, who, although not a technician himself, has the happy faculty of looking for probable scientific developments in odd corners where none are believed to be possible.

So the Colonel turned his staff on the pulley problem some time ago; and already the experimentation has proved most promising. The author was shown an alternating current motor suspended on ball bearings, the axis of suspension being coincidental with the axis of the motor, while the motor itself was counterbalanced so as to remain in any position to which it was rotated on its bearings. A spring dynamometer was connected with the motor shaft; and the speed of the driven pulley was obtained by means of a speed indicator. The amount of mechanical energy consumed was estimated with great care. The wooden pulley was then closed at its open ends so as to cover the spokes or web, and the tests were repeated. Measurements indicated that considerably less power was required to drive a pulley, and the operation was appreciably less noisy.

This demonstration has established the surprising fact that considerable power is now going to waste in many of our large shops where power shafting and transmission pulleys are still used instead of individual motor drive. One pulley alone may show but a small loss, but when this loss is multiplied many times in a large plant, it becomes appreciable especially during these times of high fuel costs.

SOME time ago we received a letter from one George Fabyan of Chicago, which read in part as follows: "I have a small private laboratory which is maintained by me for the purpose of investigating that which interests me. It is not a commercial laboratory and I am not interested in securing publicity either for myself or the laboratory. There are, however, several experiments which would undoubtedly be of interest to the SCIENTIFIC AMERICAN *and the public."*

Well, we have visited the "small private laboratory," otherwise known as the Riverbank Laboratories. It proved a surprise party. In the accompanying article, our Managing Editor tells what he saw during his visit to Riverbank. And having established this acquaintance with the Riverbank Laboratories, we shall tell you in future issues of some of the interesting studies now being conducted by that institution, in greater detail.—THE EDITOR.



Delving Into the Mysteries of Sound

Other experiments are being conducted in the mechanical laboratory, for it is obvious that mechanics figure largely in any problem that is being investigated, not to forget the machine shop work connected with general experimentation.

Leaving the mechanical laboratory, we pass on to the sound testing building, which is known as the Wallace Clement Sabine Laboratory of Acoustics. It appears that this beautiful laboratory was built for the researches of the late Professor Wallace C. Sabine of Harvard University by Colonel Fabyan, his friend. This laboratory is a three-story structure of brick and concrete, containing a building within a building, as depicted by our staff artist in the drawing on the facing page.

It was Professor Sabine's wish to produce a building in which all sound from one portion can be completely excluded from another portion, excepting as it passes through a wall whose transmission is being studied. It was no simple matter to obtain this special condition, for sound is an elusive thing which escapes from one confined place to another by various subtle means. But by the application of great skill and ingenious care the problem was finally solved to the complete satisfaction of everyone by Mr. B. E. Eisenhour of the Riverbank Laboratories staff, backed up by the keen personal interest of Colonel Fabyan.

The acoustic laboratory consists of two entirely separate structures under a single roof. It will be noted by referring to the accompanying drawing that the inner room or sound chamber is completely insulated from the outer so far as sound transmission is concerned, having its own walls and its own foundations. The sound chamber, which is below the level of the ground, is entered through steel doors as well as a heavy sound-proof door not unlike that of a huge refrigerator. The sound chamber presents a spectacle of utter nakedness, due to its huge size and height, with plain floor and walls and ceiling. Yet there are a few furnishings in the room which are all but lost because of the spaciousness. These add still more mystery to an already mystic atmosphere. In one corner there is a battery of organ pipes ranging from the little fellows with high pitched notes, down to the huge stack-like ones which roar their low notes until everything seems to quake with fear. Diagonally opposite, there is a queer cabinet with hinged doors forming the sloping top, said top having a hole through which protrudes the head of any person who sits in the chair within the cabinet. In the center of the room, some distance above the floor, there is a pair of steel reflectors which turns slowly on the vertical axis and serves to change the interference system and give a uniform distribution of sound intensity throughout the room.

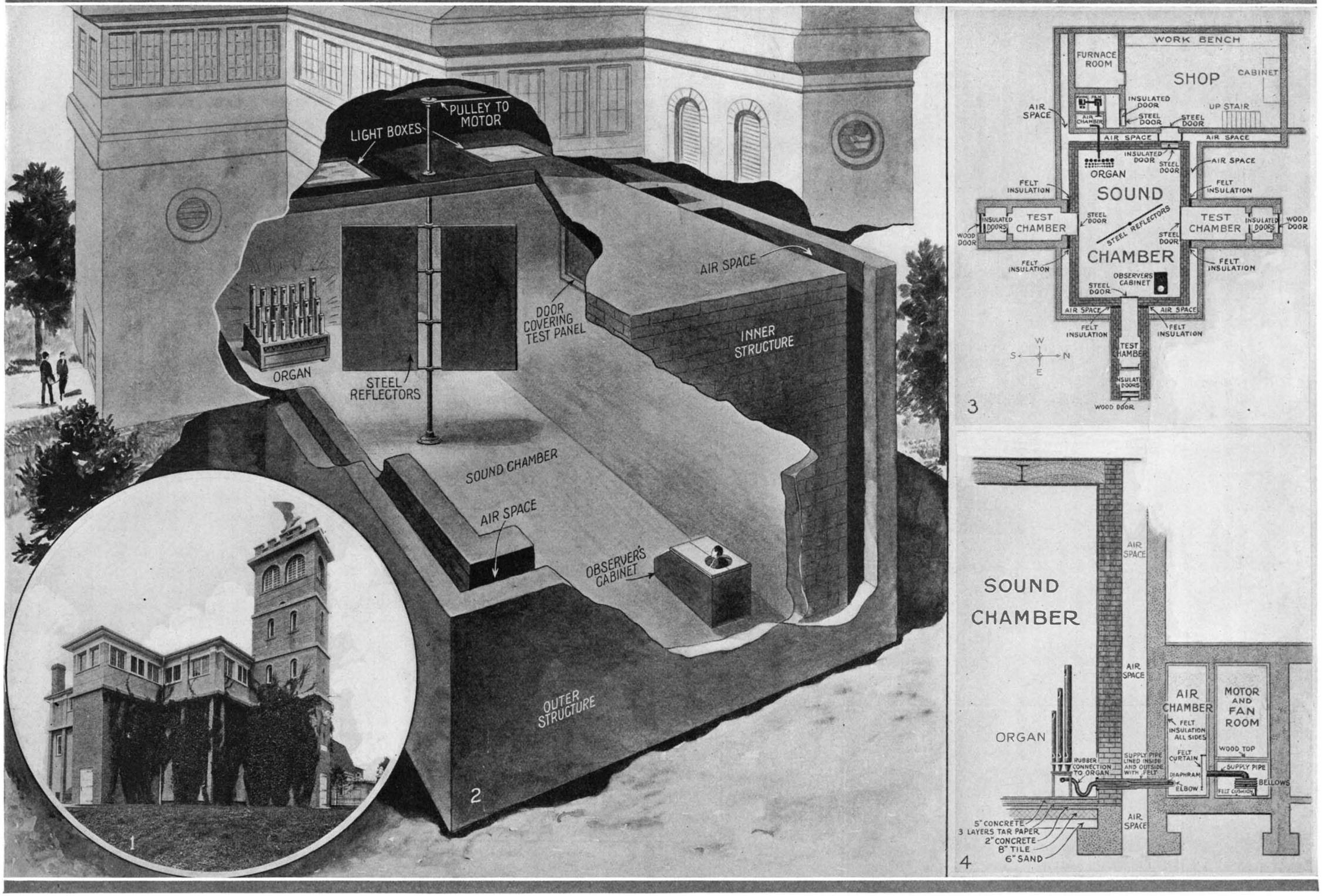
What manner of room is this? It is almost impossible to talk in this chamber, since after the third word is spoken the air is surcharged with the persistent echoes of the first two words, so that one is soon hopelessly swamped by what has already been said. To speak still louder does not help matters, because a moment later the louder echoes come back and tend to drown out still more effectively what is to follow. It now dawns on one that the best procedure is to talk in a very low tone, and to wait after every few words in order to give the echoes a chance to exhaust themselves.

The truth of the matter is that this sound chamber is highly sound tight. It requires about twelve seconds for a given sound of medium pitch to be absorbed by the four walls, ceiling and floor. With the sound absorption qualities of the room known and constant, it becomes possible to test the sound absorption qualities of various materials and structures.

Now on three walls, some distance above the floor, there are doors of steel which cover the test panels. These test panels may be built up of any material or type of construction to be tried out for sound absorption and sound conduction. When a panel is ready for test, its steel door is swung out of the way to expose the panel to the sound waves. The observer sits in the cabinet with just his head protruding, because it has been found that clothing has a marked effect on the absorption of sound waves. Within the cabin, the observer has a board with numerous pegs arranged in order corresponding to that of the organ pipes. Thus the observer can connect a switching device with any desired pipe. The switching device consists of a button which is pressed to start the organ pipe, and which starts a stop-watch movement the moment the button is released to stop the organ blast. The observer listens carefully until the organ note has just become inaudible, and again presses the button, this time stopping the watch and obtaining a reading in seconds and fractions of seconds. Obviously, this reading indicates what effect the test panel has had on the sound absorption qualities of the sound chamber, and makes possible the compilation of invaluable scientific data covering the sound absorption characteristics of various materials and types of construction.

So much for the sound absorption experiments. The same arrangement is also employed for sound transmission experiments, so as to evolve better partitions for our apartments and homes and office buildings. It

(*Continued on page 201*)



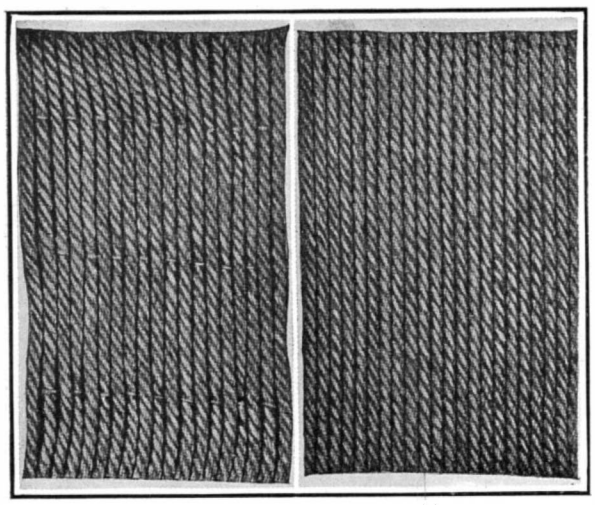
THE outstanding feature of the Riverbank Laboratories is the Wallace Clement Sabine Laboratory of Acoustics, constructed in 1918 for the late Professor Sabine of Harvard University, and in which Professor Sabine's original program of experimentation with sound waves is being carried on. This attractive three-story building, of concrete and brick, consists of two entirely separate structures under a single roof. The inner room or sound chamber is completely insulated from the outer so far as sound transmission is concerned. Separate foundations are used for the inner and outer buildings, and felt insulation is employed wherever the walls come close together to form a connecting doorway. Sounds produced in the inner or sound chamber can be tested with the utmost precision, and exact data obtained.

In the first view we have a photograph of the beautiful laboratory building and its memorial tower. The three wings, two of which show in this view, serve to house the test chambers as indicated in the third view or plan of the ground floor and sound chamber.

The second view shows the construction of the inner and outer structures. For the purpose of simplicity, this view does not show the test chambers which are in the three wings of the building. During tests of the sound reflection and sound transmission properties of materials, the observer sits in the cabinet in one corner of the sound chamber. Any pipe of the organ, which has 73 pipes, giving all the tones of the musical scale from C, 64 vibrations per second, to C, 4096 vibrations per second, can be sounded from the observer's cabinet by means of a switchboard arrangement. The observer sits in the cabinet with just his head exposed in order that his clothing will not interfere with the accuracy of the readings. Steel reflectors, turning slowly and silently, give a uniform distribution of sound intensity throughout the room. The method consists of measuring the duration of the sound after the source has ceased in the sound chamber, and also in one of the test chambers, the two being separated by the test panel being tested.

The third view shows the plan of the laboratory, while the fourth gives the mechanical details of the sound insulation between the electrically-driven bellows and the organ.

WHERE SOUND WAVES ARE PUT ON THE OPERATING TABLE: SOME DETAILS OF THE WALLACE CLEMENT SABINE LABORATORY OF ACOUSTICS AT RIVERBANK



Instead of weaving the cords into a loose fabric by means of a widely spaced weft thread and then buttering rubber over the whole, the cords are soaked in rubber milk and dried while in a position of perfect parallelism. The cords and the rubber become an integral mass, and separation of the two, which is the usual cause of a tire's downfall, cannot occur while the stresses are perfectly distributed over all of the cords

A contrast between the old and the new methods of making cord tires

Sprayed Rubber

A New Hopkinson Process of Making Rubber which May Revolutionize the Rubber Industry

By A. G. Ingalls

A NEW process of making rubber, wholly different from that at present used in the rubber industry, much less expensive, altogether faster yet simpler, threatens radically to change the entire process of rubber manufacture. It is a dream of rubber chemists and physicists come true. It represents years of research and grasping for a wholly new method of converting the solid content of the rubber milk into chemically as well as physically pure rubber in such a practical, workable manner that the difficulties involved in the process at present used shall be done away with. That method has been discovered. It has been tried and found not wanting. Not only that, but it makes better rubber than the older process—a stronger grade that is more enduring against age and more resistent to abrasion and wear.

The new process is so utterly simple, and so little involved with technical and cryptic lore that one wonders why it was not thought of long before. But hindsight is easier than foresight; while the greatness of simplicity is fundamental.

In making rubber by the Hopkinson process the snow-white rubber milk, known to the trade as latex, arrives at the factory in tanks and is atomized by a simple centrifugal device. Falling to the floor through a superheated atmosphere the spray is dried instantly, making a miniature blizzard of filmy flakes and building up a drift of uniform textured, uncontaminated, cream colored, spongy rubber resembling baker's dough.

Rubber is made in three ways. The milky juice of the tree is coagulated on the paddle of the Amazon Indian. Or it is coagulated on the plantations in pans by the addition of acetic acid and made into solid rubber by several stages, requiring the use of heavy rollers and several cleansing processes. Thirdly, it is made by the new latex spraying process. This process is fully controlled by patents owned by a prominent rubber manufacturing concern, but these patent rights probably will be leased to all other rubber makers who wish to use them.

Annually in the world about 225,000,000 gallons of rubber latex or rubber milk is made up into about 250,000 tons of rubber. Approximately ten per cent of this product comes from Brazil. The rest comes from the Far East. When we think of the source of the world's rubber supply we are quite apt to think of the damp, sodden silvas of central Brazil. It is here that our schoolbooks told us rubber was produced by the native Indian who dipped his paddle into the white latex and held it in the smoke of a small open fire until the milk coagulated. How the Indian of the Amazonas makes it still, but how the bulk of the rubber-growing industry has within recent years shifted to Malaysia, is an interesting story which has to be told, briefly, in order to prepare a background and to make more evident the contrasts with the new spraying process that has just been put on a practical working basis in the rubber world.

Rubber comes from the juice of several varieties of trees, but for practical purposes it will do to say that Hevea braziliensis is the tree that furnishes what we know as real rubber. There are several other vegetable sources of rubber, or near-rubber, such as the unrelated African bush that produces a rubber called by the trade "balata," and which is somewhat inferior. Hevea braziliensis grows wild in the tropics, especially in Brazil, but it has also been very successfully put under intensive cultivation in the Far East. Scattered through the interminable and shadowy forests of the vast Amazon basin are found the millions of wild trees which are scarified by the forest Indian, permitting the juice to ooze out. This juice is not the sap of the tree, for it has its sap in addition. Rather it is a white exudation from the inner bark or bast, and is of about the consistency of country milk or city cream. It is not sticky. No one tree gives more than a quart or two of latex, although many of the trees are large, and it may with truth be said that the 225,000,000 gallons of latex gathered annually, including the part contributed by Brazil and Malaysia, is all collected, in the last analysis, by spoonfuls.

Having gathered a container of rubber milk, the Amazon Indian builds a small fire, using for this purpose the native urucuri nuts. When burned, these nuts give off the astringent fumes needed quickly to coagulate the latex. Into the milky juice the native dips his canoe paddle and holds it in the smoke of the smouldering nuts, turning it continually as the thin coating of latex dries into rubber. This process requires the driving off of about 60 per cent of the latex in the form of water vapor. Again and again the paddle is dipped and smoked until finally a ball or "biscuit" about the size and shape of a large oval hornet's nest has been built up. The paddle is then removed from the center of the mass. Thus made, the biscuits are bought up from the natives by compradores who make their way into the wilderness to dicker with the Indian.

Rubber made in the above manner is nearly black, owing to the smoking it gets. It usually contains other impurities in quite appreciable and annoying quantities, and as these quantities vary with each particular lot of biscuits and as the impurities may run from leaves and dead bark to sand and gravel, every separate lot of biscuits has to be treated differently before it enters the finished product, such as the tire you buy. Formerly the Indian found it easy to incorporate a few stones with the biscuit, adding to its weight without adding to the work. But the buyer has learned to cut each biscuit along an axis chosen by chance and the Indian has learned that the knife is too apt to meet with his padding of rock.

Plantation rubber could be grown in Brazil, provided the white man would be willing to die with fevers and provided the native could be prevailed upon to work after he had earned enough to buy him the few things he wants from civilization. But it is healthier for the white man in the Far East, and the native supply of labor, none too energetic, can be eked out by the Chinese who are found all over Malaysia and who are very intelligent and industrious. Moreover, rubber can be grown more cheaply in Malaysia than Brazil.

It may come as a surprise to some who well remember the geography lessons of their schooldays that nearly all of the world's rubber comes today not from Brazil, but from the Far East. The Amazonian continues to produce at about the same old rate, but the automobile tire industry has called for greater expansion than he could accomplish. The Far East rubber is all grown on plantations in the Federated Malay States, Straits Settlements, Ceylon, Sumatra, Java, Borneo and Indo-China.

The rubber of Malaysia is treated by the coagulation process. This process has nothing in common with the process of the Indian and his smoky fire. Neither is a large proportion of our rub-

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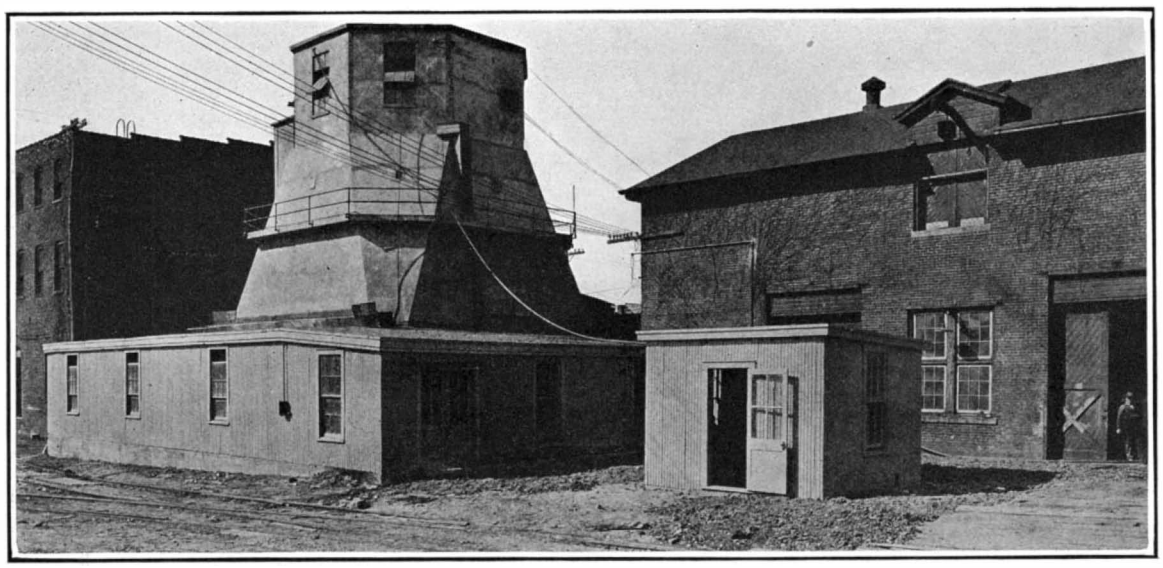
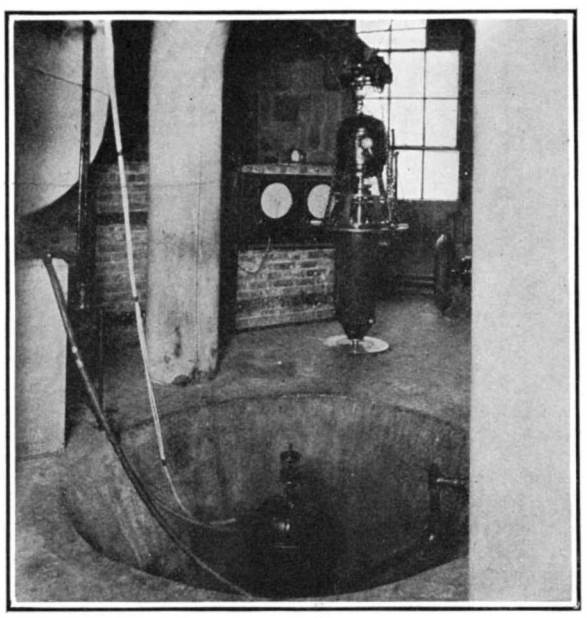


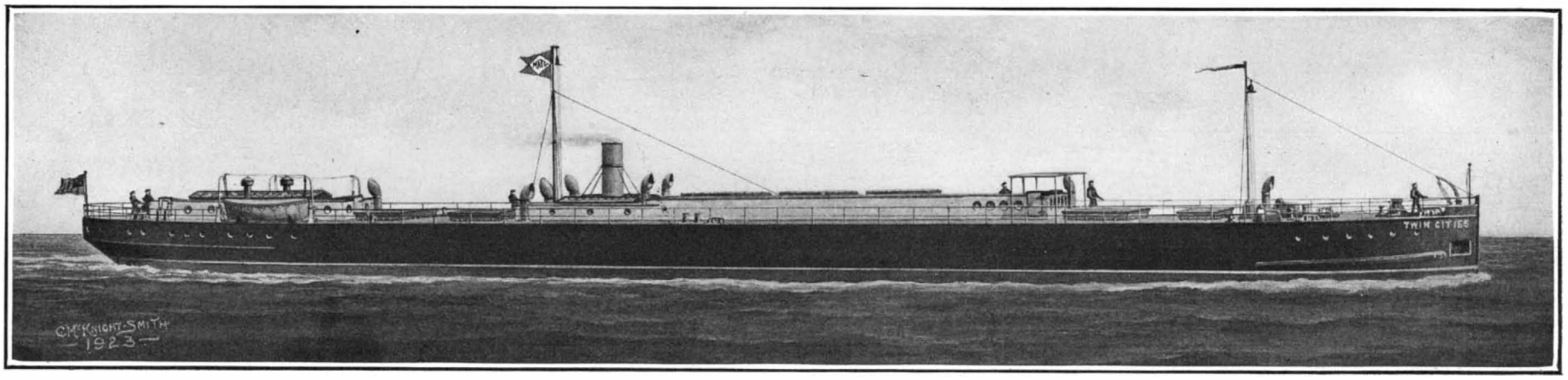
The rubber latex is received from Sumatra in a tankship, is pumped into a tankcar and conveyed to the spraying unit. It is pumped into a reserve tank in the upper room of the concrete structure and is sprayed through an opening in the floor into the chamber beneath, where it meets with air heated to 500 degrees Fahrenheit. This dries the rubber milk instantly and it falls to the floor of the large empty chamber formed by the tapering portion of the peculiar structure in the form of rubber flakes. In the shed portion of the unit the accumulated rubber is weighed and baled. Such a unit can turn out 600 pounds of sprayed rubber per hour and requires a crew of only four men to operate it

The spraying unit of the new Hopkinson process of converting rubber milk as received in tankships directly into rubber



From the reserve tank at the left the latex is run by means of a hose through an opening in the floor at the bottom of a conical depression shown in the illustration. Here it meets an aluminum disc revolving at 4000 R. P. M. in the drying chamber below and is whirled into thin spray in hot air from the brick furnace shown in the background. A spare motor and spraying disc hang in readiness from a hoist. The dials are those of thermographs for controlling the heat of the air for drying

Interior of upper portion of the spraying unit, showing the spraying and air-heating apparatus



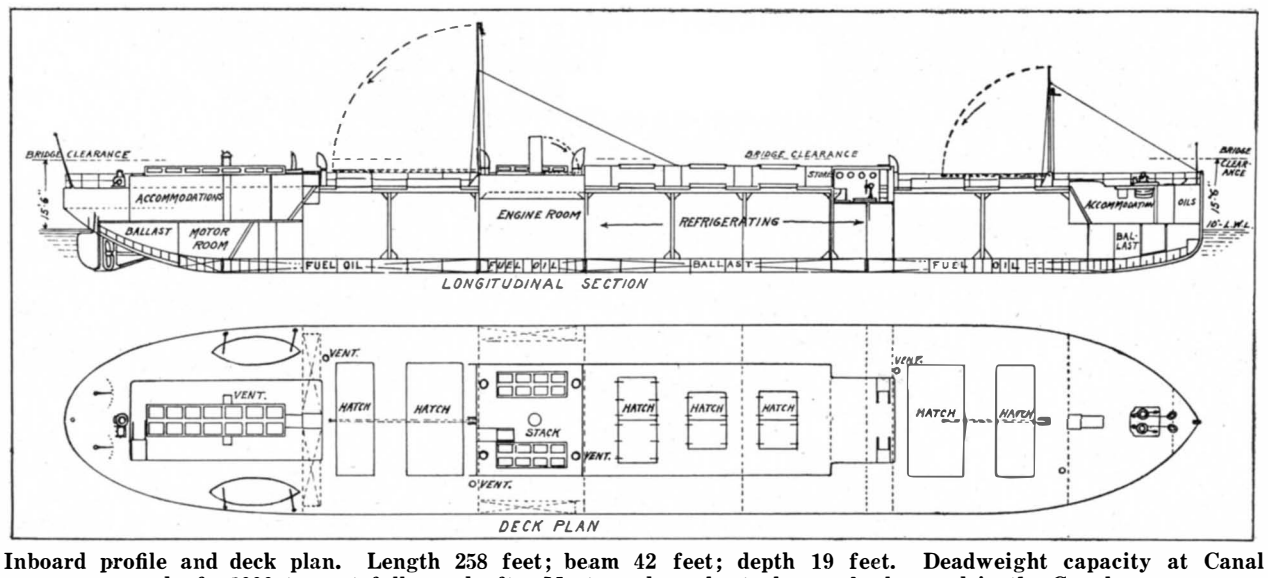
New type of lake and coastwise vessel of 2600 tons, designed to pass through the State Barge Canal

Sea-Going Ships for the State Barge Canal

Special Type of Barge Designed for Combined Lake, Canal, and Ocean Traffic

DURING the war we illustrated a new type of vessel, combining the qualities of a barge with those of an ocean-going ship, designed by Mr. McDougall, a veteran of lake transportation, which was intended to carry freight through the Great Lakes and the State Barge Canal to the Atlantic Seaboard, and thence to such coastwise or foreign ports as might be desired. This first experimental ship was taken up by the Government and gave good service during the war. With the experience gained with this experimental vessel, Henry Penton of Cleveland, in collaboration with A. Miller McDougall, designed two improved ships of the same type, which are now being built at Detroit. These vessels are designed for operation through the Great Lakes and Welland Canal, and the New York State Barge Canal via Oswego and the Hudson River, to New York and points along the coast. They are of full Welland Canal dimensions, with a length of 258 feet and a beam of 42 feet and a depth of 19 feet, and they are being built to meet the requirements of the highest class of the American Bureau of Shipping for Great Lakes and coastwise trade. Their service will cover the trade to the West Indies, the Gulf of Mexico and the Caribbean. When using the State Barge Canal, the ships will be loaded to a draft corresponding to a deadweight capacity of about 2000 tons, and at sea the capacity will be about 2600 tons. The ships have a full-length, double bottom, with stowage for fuel oil and water ballast.

The vessels will be propelled by the electric drive, and the unusual feature is the system of control of propulsion units. The gas engine will operate generators, whose current will be carried to electric motors, one on each shaft, which will be controlled entirely from the Pilot House, both as to speed and direction, by means of controllers under the hand of the officer on watch on the bridge. The main engines will run continuously in one direction at one speed. They will not be reversed or manœuvered; in fact the engine room force takes no part in the handling of the ship. This arrangement gives extreme flexibility as well as centralization of control. There is the added advantage of the elimination of the racing of the propellers in heavy water.



Inboard profile and deck plan. Length 258 feet; beam 42 feet; depth 19 feet. Deadweight capacity at Canal draft, 2000 tons at full sea draft. Masts and smokestacks can be lowered in the Canal

The propelling machinery is of the Diesel-electric type, in which two six-cylinder engines are coupled to electric generators as described above. In addition to supplying the main propeller motors, the generator also supplies current for the auxiliary machinery, such as pumps, windlasses, capstans, steering gear, refrigerating machinery, fans, lighting, etc. The living quarters are heated electrically; the galley range is of the electric type; the water for bath and other purposes is electrically heated; even the whistle is operated by a motor instead of by steam or compressed air.

Refrigerated space is provided in two holds for about 600 tons of perishable cargo; the refrigerating machine, being in multiple, to facilitate control of temperatures as well as a measure of precaution against failure. A duplicate system of fans and ducts circulates air through chambers containing coils of pipe, through which brine at a very low temperature is pumped, the chilled air being thence driven into and through the refrigerator holds. Perishable cargo, such as dairy products, for example, can thus be maintained at proper temperatures at all times and delivered at destination in perfect condition. The advantages of this arrangement, as compared with rail shipments with slow movement and frequent delays, will be apparent.

Commodious quarters are provided for the crew. The master, mates and deck crew are berthed forward, and the engineers, oilers and stewards aft, with baths and toilets for all. There is a three-berth hospital; and a fresh water supply has been installed in conjunction with the officials of the Public Health Service. As a safeguard against contamination, the supplies for drinking and cooking are drawn only from certified sources and they are entirely separate from the ablutionary supply.

The clearance between the surface of the canal and the underside of the lowest bridge structure throughout the canal is only 15 feet 6 inches—a fact which accounts for the absence of permanent masts and deck super-structures on these two vessels. The two masts shown are hinged at the deck and can be quickly lowered. The smokestack and ventilators also, are hinged and can be similarily lowered when passing under bridges.

Conservative shipping men, discussing the possibility of using ships of the Great Lakes for deep sea service, have declared that the thing cannot be done, for the reason that dimensions, proportions and scantling that are suitable for service on the lakes, produce a ship which is not suited for coastwise and trans-ocean service. Although we agree that a ship built especially for lake service is by no means an ideal ship for deep sea work, we have always believed that it would be possible to build a special type, which, structurally, would have the necessary strength for both services and at the same time would operate under no serious economic handicaps, either in the lakes or on the ocean.

Are Bees Color Blind?

WHAT effect has color on bees and are these industrious insects able to distinguish between various colors? This question has been investigated a number of times. The importance of the problem may not be evident at first glance, but it is possible that the ability of the bee to distinguish between different colors may have a significant bearing on the attraction that flowers have for it. This again may influence on the production of honey in a particular apiary, for unless the flowers were of the proper colors, the bees would not seek them out and gather the honey contained in them.

The bees were allowed to become accustomed to a certain color in such a manner that it indicated to them the food kept in small cups, which were arranged on paper of definite colors. Gray papers of different degrees of brightness, which must exert the same stimulus on the color-blind eye as colored papers, were used in the experiments for comparative purposes. In order to exclude the sense of smell, the papers were changed frequently or they were covered with glass plates. Furthermore, in order that the sense of location should not be allowed to influence the bee in conducting him to the place where the food was stored, the position of the papers was changed from time to time. In the experiments colored papers, dyed with pigment colors, colors extending over quite a range of wave lengths, were used. In order to avoid errors, which might possibly result in the experiments, monochromatic light was used.

This was done by casting a mercury spectrum on the paper, from which all the colors with the exception of a single one were screened off. The position of the same on the experimental table was repeatedly changed. The bees were allowed to become accustomed to this one color. Then the entire spectrum was thrown on the paper and the bees were permitted to discover therefrom the particular color which they had been originally broken in to.

It was found that the bees were able to distinguish easily and clearly violet up to blue and from green to yellow. Ultra-violet was also distinguished. The conclusion was reached that bees were able to recognize the colors in quite a wide range of the spectrum. In a recent issue we dealt with the color-blind aspects of several animals.

Our Point of View

Politics in Engineering

ALWAYS it is a source of relief to engineers when the practice of their calling is unhampered by the politician. Engineering is so serious and exact a profession that its members have no time, and less inclination, for that grotesque and unstable thing which we call politics. The study of physics and mathematics at college, followed by the construction of bridges, earth-works, power-plants and machinery in its multiplied forms, serves to cultivate in the qualified engineer a perfect passion for cold facts, close reasoning, and straightforward procedure. The ethics of his profession, and its practice, beget in him a wholesome distaste for the shams and uncertainties of a political life. So far as the politician is concerned, the engineer asks only to be let alone, so that he may put the very best of his knowledge and experiences into the prosecution of his work.

Hence it is that the recent removal of Mr. Arthur P. Davis from the position of Director of the United States Reclamation Service has produced positive consternation among the members of the engineering profession; for Mr. Davis is an engineer of high standing, who for an unbroken period of forty years has proved himself to be an accepted and highly capable servant of the Government. Step by step his knowledge and abilities had raised him to the position of the executive of one of the most important governmental engineering enterprises in the United States. He was removed peremptorily. No adequate explanation has been given for the change, nor has he been afforded an opportunity for defense. His removal takes on a strong color of partisan politics. Not only is the unseemly precipitation with which this distinguished and well-proven servant of the public has been dismissed a matter of profound discouragement to the engineers of the country, but the reason which is given for the change is even more so.

The Secretary of the Interior gives as an explanation —if it can be called an explanation—that he wishes to place this great public work in charge of a business man rather than of an engineer; and without showing wherein engineering control has failed, he merely abolishes the office of Director, and creates in its place the office of Commissioner. This is mere quibble. Our leading engineers have ever been distinguished by great business and administrative ability. But so it comes about that one of the most distinguished and successful of the world's engineers in great works of reclamation gives way to a country banker who, we understand, has also been a Governor of Idaho. The whole affair is at once discreditable and discouraging; discreditable, because it betrays a great lack of courtesy, and discouraging, because it is a conspicuous instance of a movement to transfer the control of engineering works from practical engineers and place it in the hands of the politicians. The SCIENTIFIC AMERICAN has always contended that the interests of the country can best be served by placing engineering works under the control of engineers and removing them, as far as possible, from the baneful influence of the politicians; for these have almost invariably looked upon the responsible positions in such work as so many plums to be given to faithful followers of the party.

The attitude of the average politician to the engineer, and to all technical men for that matter, is one of contempt for the expert. This spirit is more often than not an expression of jealousy and dislike of the man who does not know for the man who does know. Residents of New York will not soon forget the contemptuous references of our distinguished Mayor to "those experts"; and although such an attitude has no part, surely, in the motives which prompted the elimination of Mr. Davis, the Secretary of the Interior cannot blame the intelligent element among the American people if they believe that this automatic elimination of an able executive from a great public work has been prompted by political motives of the most pronounced kind.

A World Timber Famine

IN A recent letter to the President of the Chamber of Commerce of the United States, the President of the American Tree Association, Mr. C. L. Pack, draws attention to the warning of a world timber famine, which is given in the annual report of the British Forestry Commission. General Lovat, Chairman of this committee, is coming to the United States and Canada to ascertain what future timber supplies Great Britain may expect from North America. In his letter to the United States Chamber of Commerce, Mr. Pack states that the threat of a timber famine affects not alone the British Isles but the whole world. The British forestry report states that there exists a widespread apprehension of a timber famine in the United Kingdom at no distant date. The demand for timber is constantly increasing and the virgin forests are being worked out far more rapidly than was expected. Hence, the committee wishes to ascertain what reserves of coniferous timber are available for import and how long they are likely to last.

It is evident that the question of the United States timber supply is a serious one not only for us but for Europe. In a recent article on "American Individualism and European Recovery," it was stated that during the years 1913 to 1923 the ton-miles of service in the transportation industry increased from 166,000 per worker to 240,000. To keep industry going, it is estimated that 5,000,000 trees are cut down every year, merely to provide the poles to carry the wires over which pass the messages of industry; and that 200,000,000 cubic feet of wood are consumed every year in mining and quarrying. These two items represent vast quantities, but they cover only a part of the field. We must add to them the enormous demands of the railroads for ties and structural material, and of the building trades for the construction of homes and factories. Another terrible source of loss, which annually cuts deeply into our forest reserves, is fire, which during a recent five-year period was responsible for the wiping out of no less than 56,000,000 acres of forest lands.

The conditions stated above are sufficient corroboration of the statement that, unless every possible effort in the shape of protective legislation and extensive reforestation is made, not merely Europe, but the United States itself, will ultimately be brought face to face with a timber famine. Were the annual consumption a constant amount the situation would be serious; but because of the rapid growth of population, particularly in the United States, and the equally rapid expansion of industry, the consumption of timber shows an annual increase. These warnings of the American Tree Association are no mere cry of "wolf; wolf!" The menace is only too real, and it approaches at an ever-accelerating pace.

Bombing United States Battleships

AN ATTEMPT will be made this summer by the Army Air Service to demonstrate that battleships can be sunk by bombing machines operating as closely as possible under war conditions. The Navy has turned over to the Army Air Service the two pre-dreadnaught battleships "Virginia" and "New Jersey," which, it will be remembered, are among those whose destruction is called for in the Washington Treaty of Limitation.

Criticism was made of the sinking of the "Ostfriesland" two years ago, on the ground that the vessel was stationary and, therefore, presented an ideal target. In the present operations, the battleships are to be towed; and although their speed will not approach the modern battle line speed of seventeen to twenty-one knots, the targets will be towed at several knots' speed and the difficulty of registering a hit will be proportionately increased. On the other hand, there will be no defense by anti-aircraft gun fire. To compensate in some measure for this the bombing planes should fly at a height of several thousand feet. Special interest will be attached to this experiment because the first use will be made of a new 4300-pound bomb containing 2000 pounds of T. N. T. So far as we know, this is the largest bomb that has ever been constructed. The aviators will attempt to drop it alongside the ship and set the fuses so that detonation will take place fifteen or twenty feet below the surface. If they succeed in doing this, there is no question that a large area of the side of these old battleships will be blown in and their sinking will be a matter of a few minutes.

Judging by their power of resistance to these Brobdingnagian depth charges (for such they are) the "Virginia" and "New Jersey," being ships of earlier design, will be easier to put down than was the "Ostfriesland." The "Virginia" and "New Jersey" were laid down in 1902, or some years before the dreadnaught period. The "Ostfriesland" was not laid down until 1908 and great attention was paid to her underwater design, particularly with a view to preserving her flotation in case of injury by torpedo. The test, therefore, will be more a test of the skill of the airmen than of the resistance of the ships. We are of the opinion that if one of these 4300-ton bombs were detonated ten feet from the side of the "Maryland" and twenty-five feet below water, even that great ship, in spite of her elaborate subdivision and the provision of gas-expansion chambers, would succumb to the attack.

Dams Versus Droughts

ONE of our busiest industrial centers is to be found along the upper Hudson River, upon whose banks are paper mills, power plants and various industries, all of which derive their power from the flow of the river. Like all streams which head in the mountains and elevated up-lands, the flow of the Hudson is very variable. During periods of high water, the manufacturers see billions of gallons of water flowing by to waste; whereas in the dry season the river becomes so low that many of the mills have to be shut down and thousands of employes thrown out of work. For nearly fifty years past both the State and various private agencies have been considering the advisability of storing up the flood waters and passing them down, gradually, during the dry season. Not only would such a plan prevent the periodical closing of certain factories, but it would result in the saving of some 2,000,000 tons of coal a year, which have to be burned during periods of low water to keep the larger and more important industries and power plants going. During the past half century many investigations have been made of this problem, and at last a scheme has been drawn up by E. H. Sargent, Engineer for the Board of the Hudson River Regulating District, a body created by the Legislature of 1921. The plan calls for the construction of sixteen storage reservoirs in the upper Hudson River watershed with a combined capacity of five hundred and ninety-three billion gallons. The execution of the work would take twenty years and its total cost would be $30,000,000. Money is to be raised by assessing the communities and industries that would be benefited, and fifty-year bonds backed by these communities and interests are to be issued. The plants to be affected can develop at present a hydro-electric energy of 180,000 horsepower; but because of the droughts their continuous average output is only 35,000 horsepower. When the scheme is completed, the engineers claim that the flow of water in the river will be continuous and that 140,000 horsepower can be realized in these plants throughout the year.

It is one of the advantages of such reclamation schemes that the damage done by freshets will be eliminated. The most severe flood in the history of the Hudson River was that of March 28 and 29, 1913, when the flow was over 200,000 cubic feet a second at Albany and about $1,000,000 worth of damage was done to various towns along the river. If the largest of the sixteen reservoirs (that at Sacandaga) had been in existence, it is estimated that the peak of the flood could have been controlled sufficiently to prevent this damage.

Our Point of View

The Facts as to German Submarines

THE Navy Department announces that it has received an authentic official report covering the facts regarding German submarines constructed and lost during the war. It represents some four years of work in checking official records and consulting various members of the German Admiralty. In the first place, as to the total number of U-boats built by the Germans during the war, the books of shipbuilding firms holding contracts show that 281 submarines had been delivered and 197 were under construction when the Armistice was signed. As to what became of all these and the men who manned them, we learn that the losses in personnel were 5364, of whom 515 were officers. Of the submarines, 37 were accounted for by depth charges; 36 by fixed mines; 20 were lost in fights with enemy submarines; engine and other troubles accounted for 14; destroyers, torpedo-boats and sub-chasers sank 13; 8 were lost through accidental ramming; armed fishing craft accounted for 6; aerial bombing for 6, and 6 were lost in submarine nets. In addition to the above, 21 U-boats were demolished to prevent their capture by the enemy.

A study of the chart accompanying the report provides us with the geographical distribution of the losses, and we find that 56 boats were lost in the English Channel, 26 in the North Sea, 16 off the eastern coast of England, 16 were lost in various parts of the Mediterranean, 12 off the Dutch coast, 3 near Heligoland, 2 in Scopa Flow and the remainder at widely separated points on the seven seas. The location of the losses as given above is about what the daily record of the war in the press would lead us to expect. The toll of ships to be credited to the various enemies of the U-boats is something of a surprise. Thirty-seven boats destroyed by depth charges is about what one would look for; but that a nearly equal number were destroyed by fixed mines is surprising. If we remember correctly, seven to ten of these were credited to the great sea barrage of mines stretching from Scotland to Norway. Another surprise is that 20 submarines were lost in encounters with enemy submarines. It would be very interesting to know the particulars of these encounters, whether they took place below or above the surface, and whether the losses were due to gunfire, torpedo or ramming. We take it that the 13 U-boats destroyed by torpedo-boat destroyers and sub-chasers and those destroyed by depth charges should go together; in which case fast surface craft accounted for about 50 of the total of U-boats destroyed. If so, this establishes the claim of naval men during and since the war, that the most effective answer to the submarine is a fast destroyer carrying a heavy battery and a large supply of depth charges.

Super-Pressures in Steam Plants

IT WAS not so long ago that a pressure of 200 pounds per square inch at the boiler was considered to be the maximum under which a power plant could satisfactorily be operated. High pressures brought with them difficulties in the way of leaking joints, etc., and the quality of the material which was then available for steam piping, cylinders, etc., set a limit upon the use of extremely high pressures. The last two decades have seen a great development in the production of high-grade iron and steel, and materials have become available which, because of their strength and reliability, have encouraged steam engineers to run their boilers under increasing pressures. If you look at a list of the great power plants of this country today you will find that a boiler pressure of 200 pounds is comparatively rare, and that the later the date of completion of a plant the higher is the pressure employed. As to those under construction, the pressures run from 265 to 375 and 400 pounds, and there are two power plants of large capacity under construction which will use the high pressure of 550 pounds per square inch.

The objects aimed at in this movement are to secure a high thermodynamic efficiency and to secure that reduction in the dimensions of the turbines and steam piping which the great density of the high-pressure steam makes possible. That the steam engineers of the country are well satisfied with the results secured is proved by the action of an electric light-and-power company in Boston, where they are about to install a turbine plant in which the boiler pressure is to be not less than 1200 pounds per square inch.

As if this were not sufficient, we learn from *Engineering* that there is being built for the Willans Works at Rugby, England, a steam turbine whose boiler will be operated under the amazing pressure of 3200 pounds per square inch. Commenting upon this courageous venture, our contemporary draws attention to the interesting fact that, since, as the pressure rises the steam becomes denser, and the water, on the other hand, less dense owing to its expansion by heat, there must come a point where the steam and water will arrive at a state of equal pressure, temperature and density, or to put it another way, they will become indistinguishable from one another. This point is reached at a pressure of 3158 pounds per square inch and a corresponding temperature of 705 degrees Fahrenheit. At this point, also, the water can be changed to steam without any surface of separation. The containing vessel may be solidly filled with water under this high pressure and temperature, since it becomes steam throughout its mass when the temperature is sufficiently high. The cycle of operation of the Rugby plant as calculated by Professor Callendar is as follows:

At a pressure of 3200 pounds per square inch and a temperature of 706 degrees Fahrenheit, the volume will be 0.052 cubic feet per pound and the heat required is 820 British thermal units per pound. The steam is throttled down to 1500 pounds absolute and a corresponding temperature of 596 degrees Fahrenheit. It is then heated at 1500 pounds to 700 degrees Fahrenheit. The steam is then expanded adiabatically in a high-pressure turbine to a pressure of 250 pounds. The steam is next reheated at 250 pounds to 700 degrees Fahrenheit, and then expanded in a second turbine down to a vacuum of 28 inches. The heat available for work in the two turbines is 571 B. t. u. and the total heat supplied is 1471 B. t. u., giving a total over-all efficiency of about 38.8 per cent. The operation of the Benson turbine, so named after its inventor, will be followed with close interest by steam engineers.

Decline in World's Shipbuilding

THE dislocation of the shipbuilding industry by the war left the merchant marine of all countries in such a state of unstable equilibrium that even today, nearly five years after the close of the war, the situation is very confused. The enormous increase in the output of the shipbuilding yards, particularly in the United States, carried the world's total of shipbuilding to a point far above the demands for cargo space, even in normal times. Except in this country, where the shipbuilders decided to complete their vast building program, there was a more or less severe slump in building activities, and for the past few years the shipbuilding yards of the world have been in a rather bad way.

The last report of Lloyd's Register of Shipping covering the quarter ending June 30, shows that on that date the shipping yards of the world had a total of 2,250,000 gross tons of work, which is a decline of 300,000 tons below the figure for the previous quarter. The statistics of new construction show that Great Britain and Ireland lead with 1,338,000 tons; then in their order follow Germany, 352,400 tons; France, 179,900 tons; Italy, 141,500 tons; United States, 133,700 tons; Holland, 100,000 tons; Japan, 72,800 tons, and British Dominions, 45,000 tons. It will be noted that Germany holds the second place among the shipbuilding countries and that she is building twice as much new tonnage as her next competitor, France. This was to be expected because of the great depreciation of the German merchant fleet, by the handing over of the largest and choicest part of it to the Allies as part of her reparations.

Comparing the above figures with those for the last quarter of 1914 prior to the war, we find that the United States yards were building 15,000 tons less during the last quarter of the present year and the British yards about 400,000 tons less. Since shipbuilding affords a reliable index to world prosperity, it is evident that there is a long way to go before industrial equilibrium is again restored.

Seventy-five Years Ago

FROM the earliest days of railroad travel, the question of high speed has excited the public interest. Thus in our issue of September 9, 1848, it is recorded that a new engine, with 5-foot 6-inch driving wheels, pulled a train of five passenger cars carrying 250 passengers from Springfield to Hartford at the rate of 50 miles an hour; "the quickest trip ever made in this country with a heavy train over any railroad." Those were the days when English locomotive builders were in favor of large-diameter driving wheels for fast trains, and the Editor suggests that with larger wheels a speed of 50 to 60 miles an hour could be obtained. Our builders made the experiment, but soon returned to the 5-foot 6-inch driving wheel, which remained the standard size for 30 years or more.

That 75 years is sufficient to carry us back to the beginning of things is realized when we read as follows: "The City of Providence is taking measures to light its streets with gas. The Almy Gas Light Company have commenced laying pipes and putting up fixtures. The place having been heretofore badly lighted, the inhabitants evinced great joy at the new way of illumination."

And while on the subject of modest beginnings, take note of the following: "Very few railroads in this country can show greater percentage of increase in their receipts of the last six months than the Macon & Western Railroad of Georgia. From a statement just published, it appears that the total receipts for August, 1848, were $12,476 and August, 1847, $9,441."

The August editorial page opens with an announcement of the discovery of an immense bed of gold, 100 miles in extent, on the Fork and Feathers River, California. The gold is recovered by "washing out the sand, in any vessel from a tea saucer to a warming pan." The American settlements were deserted, we are told, farming nearly suspended, ships lost both their sailors and captains, and not even $10 a day would tempt laborers to return to the farms." All of which, by the way, sounds very modern.

How many of our readers are aware that the United States Navy, 75 years ago, made a survey of the River Jordan and the Dead Sea. As told by Lieutenant Maury, the story reads like a romance. Two metallic boats, one of copper and the other of iron, were transported over the mountains and launched on the Sea of Galilee. Galilee was navigated and a survey of its bottom made. The deepest sounding made was 1128 feet. There is nothing that the Navy cannot do. Well might the Editor exclaim: "It is a specimen of the skilled system and discipline of the American Navy."

Very interesting is a letter in the September issue from Elias Howe, Jr., of sewing machine fame, dated from London, which opens thus: "I am in the regular receipt of your valuable paper (through my father in Cambridge, Mass.)," and goes on to give particulars of a French sewing machine which had appeared in an earlier issue. The letter proceeds: "I wish to say to your correspondent that I expect soon to submit a sewing machine which will stitch and sew in the same manner as is done by hand . . ." Howe had just secured a patent in London to which he refers by saying that "John Bull is thick upon some matters, and upon that seal is decidedly thick."

Bringing Order Out of Chaos

The Emergency Job of Reconstruction after Philadelphia's Station Fire

By William A. McGarry

PROBABLY without parallel for sheer speed in peace-time experience was the engineering feat accomplished recently at Broad Street Station, Philadelphia. Passengers in and out of that terminal of the Pennsylvania Railroad look up today at the vanishing remains of a rusted, fire-blackened steel skeleton that once supported the largest arched train-shed roof in the United States. They see little figures of men swarming about with oxy-acetylene torches 150 feet in the air to cut away the twisted girders, cranes dropping them to flat cars, and the latter moving in and out with no interruption to the regular train service. They probably marvel at the efficiency of a system that can run a train a minute under such circumstances. But the task today is relatively simple compared to what was done in three days after the train shed burned down.

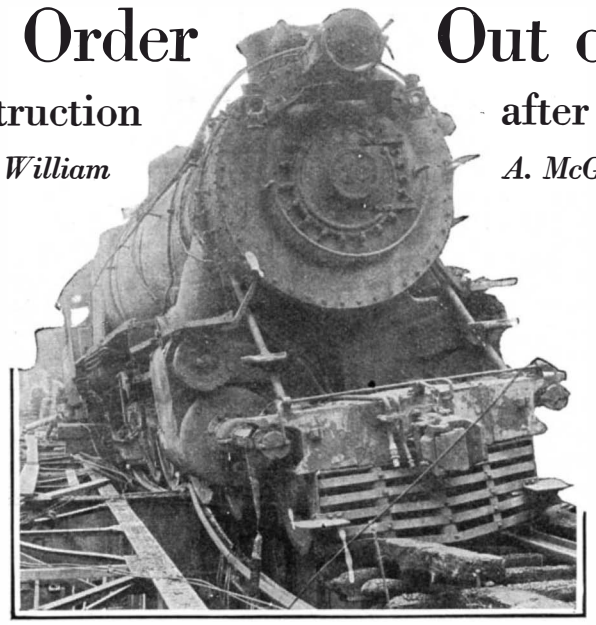
Broad Street Station stands at the juncture of West Penn Square and Market Street. The Pennsylvania main lines run directly west from there on an elevated structure, paralleling Market Street. Fifteenth Street is crossed by girders carrying the passenger platform, just outside the gates; the elevated structure is carried over all other cross streets by brick arches. The station office building is a seven- to ten-story brick structure occupying the space between Penn Square and Fifteenth Street.

Virtually all the space under the elevated structure between the cross streets is utilized by the railroad or allied services. The surface of the road was carried within the shed on ties set in concrete, which rested in turn on a girder system. When that was built 26 years ago it was quite adequate to carry the rolling stock then in use. But as equipment became heavier the company found it necessary from time to time to strengthen the supports of the tracks. To that end steel and wooden uprights and girders had been put under the old work. Beneath the concrete of the train floor was six feet of this heavy wood work, boxed in from below by the ceilings of storehouses, engine rooms, a post office sub-station, baggage rooms, etc.

Likewise, although the roof appeared to be of steel and glass, there was quite a bit of timber in it and much tar paper and similarly inflammable material. The fire started at 11:45 p. m. on Sunday, June 10th, with a trickle of smoke under the platform between tracks 11 and 12, and at first it seemed a simple task for the station firemen to check it. Within five minutes, however, they had discovered that the blaze had gone down into the garret-like area below the tracks, and within an hour 25 city fire-fighting companies had arrived and all the apparatus in the city had been shifted. By that time the burning of wires had disrupted telegraph, telephone, signal and train-starting systems; and fire in the engine rooms had put out of service the air compressors for the operation of the switches, and nearly every other phase of the terminal system. The fire swept the whole length and breadth of the great shed in the area beneath the tracks and over the surface platforms, crawled up the steel and brick walls and shot hundreds of feet in the air as it licked its way across the acres of glass above.

The interior of the shed was obviously untenable for human life, with smoke, flame and melting glass. But somehow railroad workers operating in the most complicated system of tracks in the world, got into that shed with switching engines often enough to drag out a string of sleepers bound for Boston and filled with slumbering passengers, most of whom knew nothing of the fire until they arrived in the Hub the next morning. They also saved all but 21 passenger coaches and three locomotives. In the meantime the fire had jumped a hundred feet over Market Street to the upper floors of a steel skeleton which is to be a theater and office building, and burned out six floors of timber forms for concrete.

At that time, when experienced firemen were beginning to talk of dynamite to prevent a possible city-wide conflagration, when fire crews had been called out by a dozen skyscrapers and when the station itself seemed doomed, the work of reconstruction started. Over borrowed circuits calls began to go out for division engineers, supervisors, master carpenters, trainmasters and all sorts of technical experts; also for section gangs and common labor. Heads of employment agencies and supply houses were routed out of bed at three o'clock to take orders for men and materials.



After the blaze—a locomotive delicately balanced across a girder

The first actual work, of course, was the removal of debris. Shifting crews and section gangs became "smoke eaters" to do that, handling red-hot materials with all sorts of improvised tongs at the very edge of the burning area, tearing up platforms still burning and otherwise making way for new construction. In the meantime other forces were preparing new schedules to use improvised stations in various quarters of the city for the handling of passengers over the commuting lines.

By daybreak a group of men out beyond the fire area, near Seventeenth Street, had gone to work on the brick retaining walls overlooking Market Street on one side and Filbert Street on the other. In a short time it became evident they were constructing temporary stairways. At about the same time shifting engines began to crawl over the network of tracks with loads of cinders and timber, and a growing force of carpenters got to work laying platforms right up to the edge of the burned section. Another gang wearing asbestos gloves started stripping everything loose from the train-shed roof. In spite of the new fire raging underneath, platforms of some kind were shoved up to the train gates so that even on Monday the company operated 38 trains in and out of Broad Street Station.

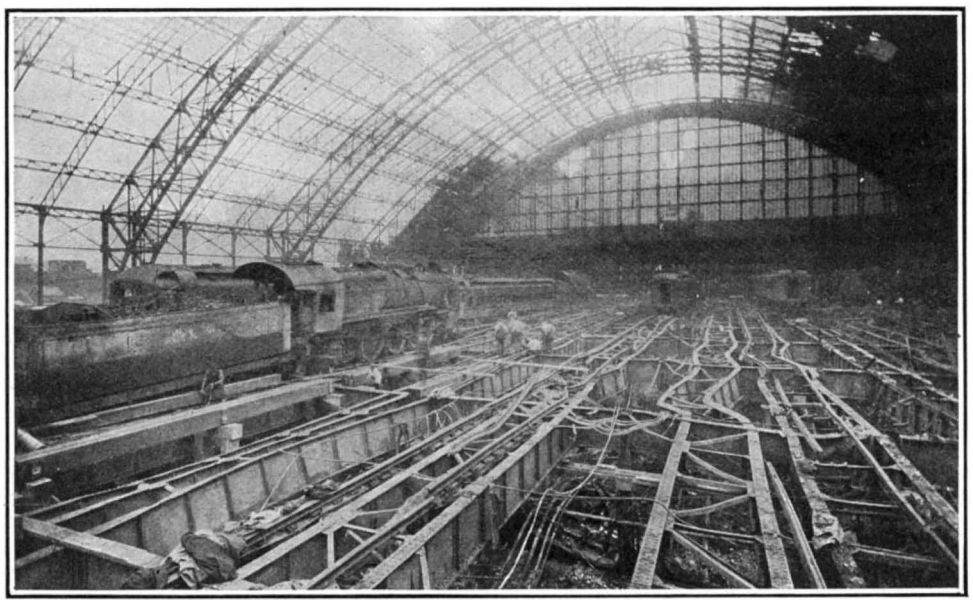
The rate of progress after that may best be indicated by the number of trains operated. It should be borne in mind that the second fire burning underneath the shed was at its worst on Monday afternoon, completing the destruction of wires, compressed air and similar services. On Tuesday, however, 142 trains ran in and out. On Wednesday 151 were handled. Thursday enough tracks had been straightened out to run 245, and on Friday and Saturday 275 trains were cared for in the ruined station. In just nine days all sixteen tracks were restored and ready for service, and 300 of the 530 trains normally operated out of the terminal were running on regular schedule. It was not possible to bring in the others because it was necessary to use from four to six tracks for the reconstruction work.

More than 1400 men were employed on day and night shifts Monday, and that number was increased to nearly 3600 three days later, when the worst of the emergency task was concluded. All that has been described, however, was more or less simple compared to the accomplishment underneath the train floor in which every phase of engineering was brought into play.

Before a single train could be run up to the gates it was necessary to replace the destroyed support timbers. By the time the smoke had been cleared out of the shed it was found that one locomotive had fallen partly through the concrete floor, bringing up in precarious balance across a few partly burned girders. The floor was not strong enough even for the electric suburban equipment.

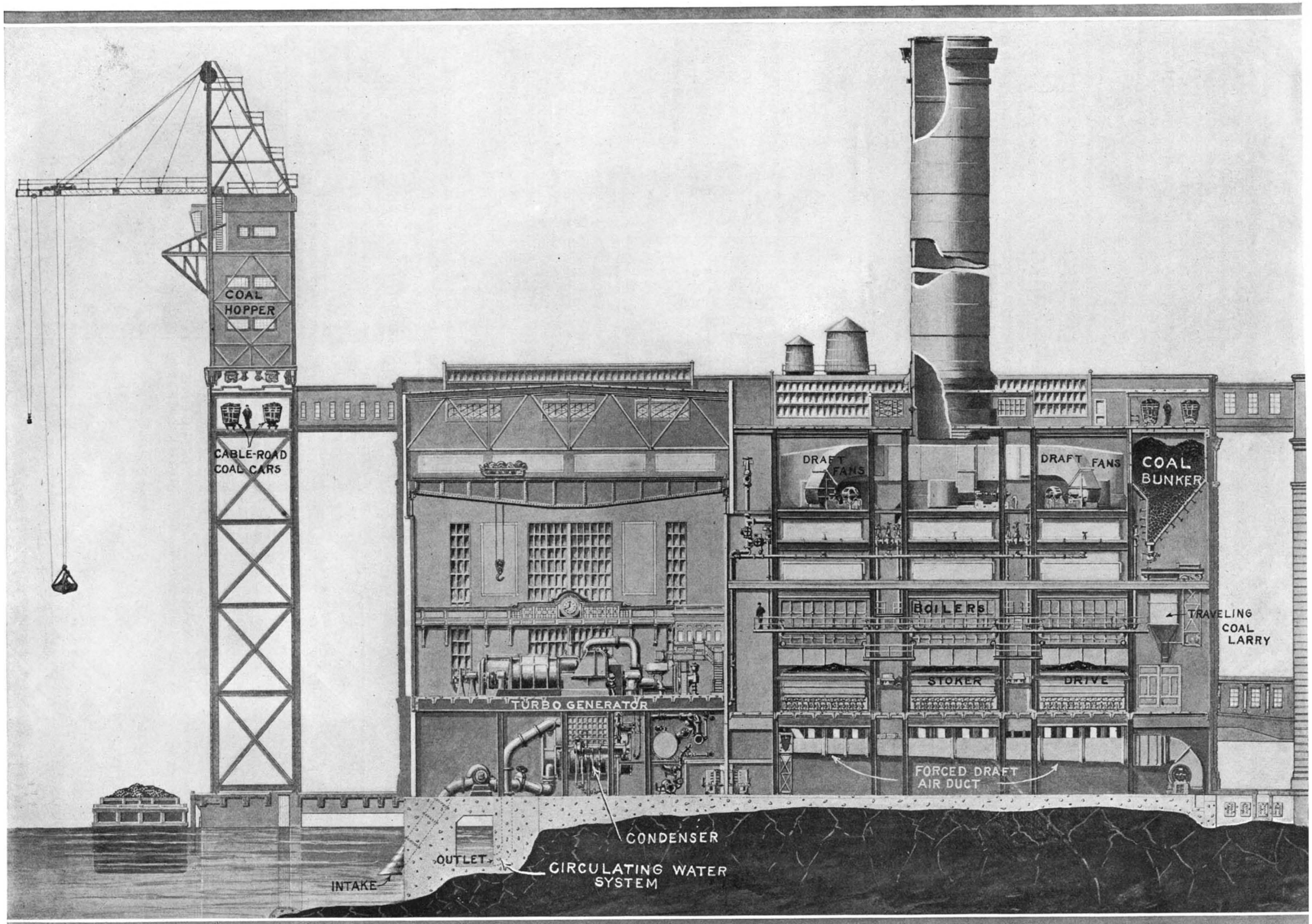
Early on Monday morning the lumber yards were delivering timbers into the side streets just beyond the danger area, and before noon a half dozen portable sawmills arrived. It was not then possible to invade the whole area underneath, but men managed to get into partly cooled and burned-out sections in order to shore up a track or two. After them—or rather with them—went the electricians. In some instances they succeeded in forestalling the fire, cutting into cables out on the line and carrying emergency loops into the station. The railroad owns the property paralleling its line on the north, and over the tops of these were strung by daybreak more than 400 pairs. As soon as the ruins had cooled enough these were bunched and carried through windows into the terminal room.

A list of the electrical work would read like a catalog. Suffice it to say that in seventy hours after the first fire started the train-starting system was reestablished, with indicators on all the tracks; the telephone and telegraph lines temporarily shifted to West Philadelphia were operating out of the main offices in Broad Street, and all the other complex parts of the system were in working order in so far as wires were concerned. The power restoration was just as rapid. It should be stated that the railroad runs commuters' trains on two of its most heavily traveled lines by electricity. For the convenient handling of these trains every track of the sixteen in the train shed had an overhead trolley wire, and naturally all of these came down, together with much of the side supports. Workmen restored them first on temporary supports, a foot at a time, following the smoke, and later put in more permanent stanchions.



General view of the wreckage in the Pennsylvania Terminal in Philadelphia, with the electricians patching up the nerves of the train-control system

The story of how the old train shed is being removed is also of interest. It stood a gaunt and twisted skeleton after all the flames had been extinguished and officials had long realized that it could not be restored. Plans were drawn for a traveling platform to operate on four tracks, with clearage of passenger trains and of the umbrella sheds which are to be built over the platforms between tracks. The main wheels of the platform run on tracks 7 and 10. Tracks 8 and 9 are being used to load and haul away the steel work, and the outer ends of the platform or apron are carried on tracks 1 and 16. On the platform are derrick booms and other equipment to bring down the steel after it is cut. It is estimated that every vestige of the fire interfering with passenger traffic will have been removed within eight weeks of the day it ended, long before which time all the umbrella sheds will have been completed along with the other reconstruction work.



THE coal for this power plant is received in barges and unloaded by means of bucket hoists. The bucket hoists deliver the coal to the hopper in one of the two coal towers, whence it passes down by gravity through the coal crushers and into the cable-road coal cars below.

The cable-road coal cars operate automatically. When filled, they move along through the cable gallery to the coal bunkers, where they automatically empty their load and return again to the coal hopper. Also, a certain quantity of coal is sent to the storage yard, not shown here, which has a storage capacity of 100,000 tons.

From the coal bunkers, which have a total capacity of 3300 tons, the crushed coal passes down to the traveling coal larry, which in turn carries the coal down its aisle in the boiler room, to the various automatic stokers of the boilers.

The crushed coal gives an intense heat in the boilers, under the forced draft. It is steadily fed by the automatic stokers, while the ashes are automatically and continuously removed at the bottom and dropped into a hydraulic sluicing system so as to be carried out in a stream of water to a reclaiming basin outside, for subsequent removal by barge and truck.

The high-pressure steam of the boilers drives the turbo-generators. Contrary to usual practice, the generating end is placed nearest the river because the circulating water system is materially simplified thereby. The circulating water system serves to condense the exhaust steam.

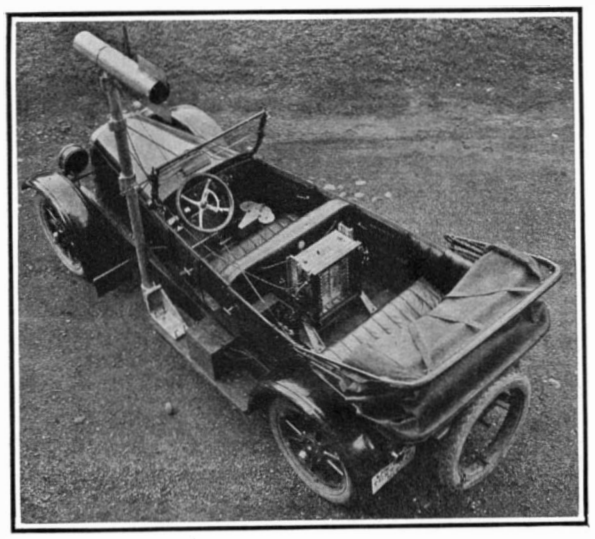
The distributing or current-handling end of the station is placed in a separate building at the right, not shown.

CONVERTING THE LUMP OF COAL INTO ELECTRIC POWER AND LIGHT: NEW YORK'S HELL GATE STATION, REPRESENTING THE LAST WORD IN GENERATING PRACTICE

Sixteen-to-One Automobile Testing

Extraordinary Assembly of Apparatus for Making Many Tests on a Single Run of a Motor Car

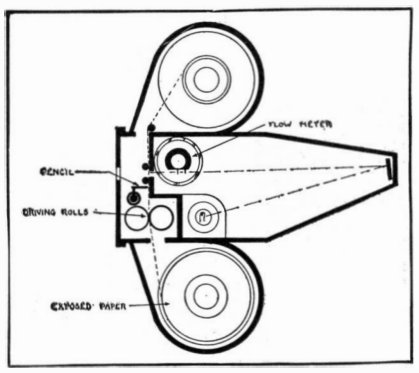
By S. R. Winters



The Bureau of Standards test automobile, equipped for sixteen simultaneous determinations of important features of gasoline performance and car economy

THE automobile engine may be tested in the laboratory, under ideal conditions; but it must run on the road, under conditions far from ideal. When traveling along the highway at a speed of forty miles per hour, more or less, the behavior of car and engine presents so many aspects that, for their competent observation, more observers would be required than could possibly be packed aboard the car. It is in this emergency that the inventive faculty is called into play; the Bureau of Standards has recently devised an apparatus that automatically and autographically records the action of the car, in sixteen separate particulars, requiring at most the attention of one or two operators in addition to the driver. This makes it possible to conduct road tests on a basis never before dreamed of, as regards both accuracy and completeness.

The rate of flow of gasoline in an automotive engine is an index to the rate of energy input. Obviously, then, the first object was to find a suitable instrument for determining the flow of the gasoline. A flow-meter was selected, comprised of a vertical tube slotted parallel to its axis. A light piston moves vertically in the tube. Gasoline enters the latter at the bottom, flowing freely out of the slot below the piston into a ring-shaped space through which the position of the piston may be seen. The pointer affixed to the piston, moving over a vertical scale on the central tube, indicates the effective length of the slot. Knowing this, and knowing the pressure, the rate is indicated.



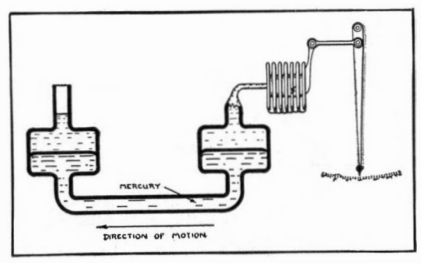
The mechanism of the flow-meter camera

Preliminary experiments involved the use of photographic records secured by focusing an image of the scale and pointer of the flow-meter on a moving film. The bulkiness of this type of flow-meter camera operated to a disadvantage, and the design was displaced by one in which the camera traces lines of the scale and pointer by means of shadows on a roll of bromide paper. Time intervals are controlled from a contact mounted on the tachometer of the car; and these are impressed on the fuel-flow film by the alternating increase and decrease in the intensity of the illumination on the bromide or sensitized paper.

How much energy or thrust does it require to move an automobile on a level highway, down hill, or upgrade? The apparatus described replied to this question in terms of the power output of the engine. An accelerometer was employed, which is essentially an instrument for measuring the force acting on a "free body" to supply the latter with the constant increased velocity which is to be accurately determined. Such a device appraises the linear acceleration, positive or negative, of the automobile mass, and takes account both of the velocity and of the gravitation factor.

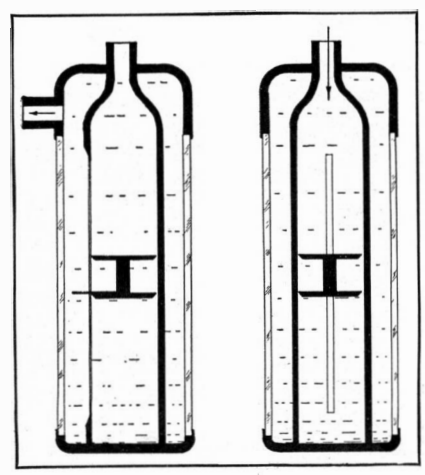
The "free body" employed in the particular accelerometer used in these experiments consisted of a column of mercury mounted parallel to the wheel-base of the motorized vehicle. The gage element, an abbreviated connecting tube, as well as the space above the closed end of the mercury column, were filled with a light oil. When the tube containing the mercury column is acted upon by an increased velocity parallel to its long axis, a hydrostatic pressure is exerted in the oil, thus balancing the force required to accelerate the mercury. This pressure is recorded by a pen-arm affixed to the compression element. Oil is an agent of pressure transmittal which not only minimizes the motion of the mercury but reduces the lag of time in the instrument.

Automotive engineers are familiar with the formula relating to the operation of an automobile, namely, that the engine power at the clutch required to propel the vehicle is the aggregate power needed to overcome half a dozen counter forces. First, of course, is the force—measured as the product of the mass and its linear acceleration—necessary to overcome the inertia of the car. Then we have the mechanical friction losses—that is, the energy squandered in the transmission, universal, differential, rear axles, and wheel bearings; the tire-rolling losses; the energy consumed in overcoming windage; that employed to fight the gravitational pull in climbing grades; and that which is used up in developing the angular acceleration of rotating parts. The accelerometer, however, when functioning in an automobile being propelled over the highway, confines its determinations to that portion of the power expenditure of an engine necessary to overcome grades and produce linear accelerations. The other four counteracting forces—friction in power transmission, tire losses, windage, and rotational inertia—may be measured by this instrument as a negative acceleration. This is accomplished by permitting the motor-propelled vehicle to coast in neutral. Friction wastage in the engine may be taken cognizance of by coasting with the clutch engaged over the transmission in gear. The energy absorbed and yielded by the angular accelerations is primarily reposed in the wheels and this expenditure of power may be calculated from the changes in the machine or wheel speed. The moment of inertia of the wheels can be determined directly by the pendulum method. Such a method of measurement acts upon the assumption that the readings of rolling and frictional resistances under power conditions are identical with those when coasting is resorted to. Exact precision is not thus vouchsafed, but in the interest of simplicity and popular application of the method, it adequately answers for all practical purposes.



Diagrammatic sketch of the accelerometer

"The wind bloweth where it listeth," is a Biblical observation that is necessarily recognized in any experiments that would accurately reflect the conditions under which a motor-propelled vehicle operates. Both the velocity and direction of wind exercise an influence on the motor-car in action. Acceleration measurements, in the interest of accuracy, have to include the speed as well as the course of the wind. The direction of the latter in relation to the movement of the automobile is significant because of the increase or decrease in the effective frontal area. A double-tube Venturi, mounted three or four feet above the top of the automobile, and supported from the running board, measures the relative velocity of the atmospheric current. This unit of the engine-performance testing apparatus is free to revolve about a vertical axis, and is maintained in the wind by vertical vanes in proximity to its exit end. The angle between the direction of the wind and wheel base of the motor-car is conveyed to a recording pen by the angular movement of a flexible shaft.



Structure and working of the flow meter

The speed of the test automobile is determined by an aircraft tachometer, geared to a front wheel. The spindle, which ordinarily is equipped with an indicating hand, is in this case provided with a small pinion linked to a recording pen. This tachometer has no time lag and registers the average speed of the automobile during the preceding two seconds.

The many-sided, compactly-built, recording unit uses, for almost all its work, a single recording drum. Speed of the automobile, acceleration, velocity of the atmospheric current, direction of the wind, manifold pressure, water-outlet temperatures, water-inlet temperature, oil temperature, carbureter-air temperature, tranmission-lubricant temperature, differential-lubricant temperature, weight of air used by the engine, fuel temperature, and air temperature are all graphed, in inks of varying colors, on a single strip of paper, moving at a non-variable speed of one-tenth of an inch per second. The paper supply is adequate for an uninterrupted service of one hour. The gasoline flow-meter camera is a separate unit, a 12-exposure kodak film being used for retaining the impression.

The faithful observations of this humanized recording unit are attuned in harmony with the records of the flow-meter, this delicate adjustment being made by individual timing devices placed on each of these instruments and driven by a single time-contact on the tachometer. The recorded observations are made on unruled paper and the readings are made by use of celluloid template, oriented into position by reference points and lines, and marked with the calibrated pen-paths. The supply of paper, record roll, and the driving element, constitute one unit and its removal for reloading is possible without upsetting the testing portions of the apparatus.

Little wonder is it that this test car, with its multitude of ramifications, should have been accorded a weird reception through the rural sections in which preliminary experiments were conducted. With the radio-telephone on the crest of its popularity, the off-hand conclusion of the spectators alongside the highway between Washington, D. C., and White Sulphur Springs, West Virginia, was that this automobile was equipped with a wireless outfit. This theory having been summarily exploded, observers were wont to characterize the mechanism as a creation for ferreting out moonshine distilleries.

High-Altitude Mountaineering

IN the *Geographical Journal* for March, 1923, Mr. G. I. Finch presents some of his findings on the physiology of high-altitude mountaineering. Mr. Finch bases his conclusions on his experience in climbing Mount Everest. Up to 21,000 feet the climber's physical functions were found to be practically unimpaired and good sleep and recuperation from fatigue were possible, but at 23,000 feet sleep was fitful, appetite fell off, and there was a general loss of physical fitness. The conclusion is that at, say, 22,000 feet acclimatization to altitude ceases and above that height oxygen should be used, at first in small doses, and from 26,500 feet in larger doses, but the dose must depend on the nature of the ground. It must also be remembered that oxygen increases the appetite, and due provision must be made for this. The stimulating effect of cigarette smoke was noted at 25,500 feet. Although greater heights than these were reached without the use of oxygen, Mr. Finch thinks this procedure unwise, and believes that above the acclimatization level a man must become steadily weaker and unable to recover from fatigue unless he makes use of oxygen.

The Trial Trip of the "Leviathan"

A Five-Day Test of the Motive Power, Equipment and Operating Staff

THE trial trip of the "Leviathan" took place over a distance of 2185 miles, on the course shown on the accompanying chart, and lasted from Thursday, June 19, to Sunday, June 24. Starting from Boston Light, the ship passed around Cape Cod and, at Nantucket Lightship, laid her course for Abaco Light. She then passed through the Providence Channel to the Florida coast, and from Jupiter Inlet Light she ran on a northerly course for a 25-hour test at maximum power.

This was the third trial trip of the "Leviathan." The first took place in the North Sea, in the early summer of 1914, when she was fresh from the builder's hands; and, as in the recent test, she carried a large number of invited guests. The next trial was made after her hasty transformation into a transport for American troops during the war. The present lengthy trial was rendered necessary by the extensive overhaul of the main engines; the change of the boiler plant from coal to oil-burning; the complete reconstruction of a large part of the passenger accommodations; the redecoration and refurnishing of the whole ship; the substitution of entirely new lighting, heating, and plumbing systems, and the general reconstruction of the ventilating system.

All practical shipping men know that the responsibilities and strain upon the operating staff of a large ocean liner increase more rapidly than the increase in the size of the ship; and they will agree that the decision to give this great vessel, upon whose reconditioning over $8,000,000 had been expended, an extended trial, under conditions similar to those of a regular transatlantic passage, was a wise and necessary precaution. Although the most important trial was that of the motive power, a thorough test was made, also, of every part of the equipment and of every department of the personnel. The program of the trial, as handed out to the guests, called for the swinging out of the life-boats by the crew; daily boat musters for the crew with the passengers assembled with life-preservers on; fire drills with operation of the hose and closing of watertight fire doors; tests of the Rich fire-detecting system covering the holds; to say nothing of tests of the powerful Sperry searchlight of 450,000,000 candle-power on the foremast, and of whistles, sirens, telegraphs, ventilating systems—257 in number—salt- and fresh-water sanitary systems, and a score of other elements in the makeup of a giant, high-speed liner—that most complicated of modern constructions.

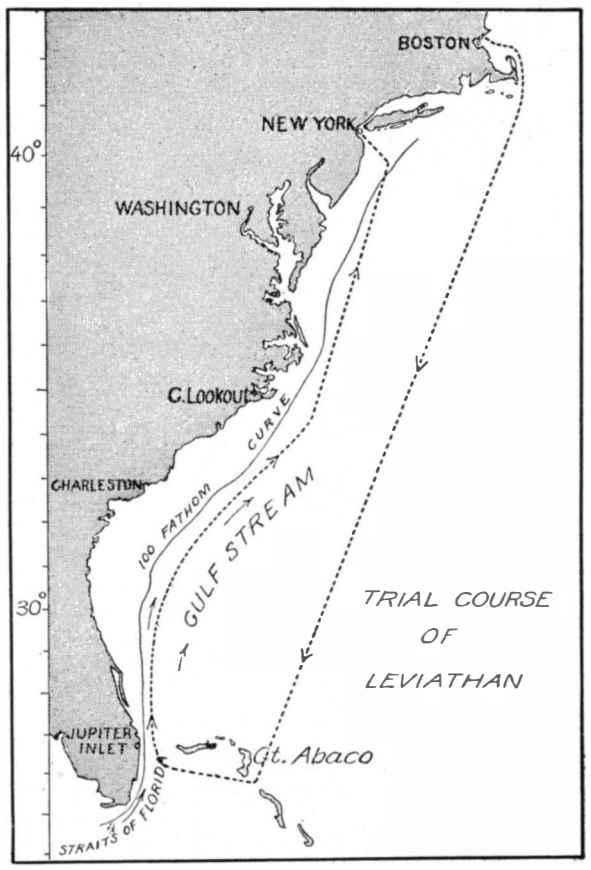
The plan of the trial called for a gradual working up of the power from that represented by 150 revolutions of the propellers at the start, to the final operation of the ship at maximum power for a period of 25 hours, On leaving Boston Light the revolutions were 150 per minute. This was maintained for 12 hours, the technical staff taking engine-room data for the last four hours of the twelve. The revolutions were then gradually increased to 160 and maintained for 12 hours, data being taken during the last four hours. Then, for successive periods, the revolutions were increased to 170, 175, 180, and finally to the maximum, with all burners going, if necessary, in all of the 46 boilers. It should be noted that, unlike the Cunard and White Star ships, which use the low-pressure White burner, the "Leviathan's" boiler plant is equipped with the Peabody high-pressure burner; an American type, which gave excellent results throughout the trial.

There was fog on the first night out, and this caused the ship to fall several hours behind her schedule. She rounded Abaco Light about midnight, June 21; passed at high speed through the Providence Channel; and in the early morning swept into the Gulf Stream. Turning north she had Jupiter Inlet Light abeam at 7:17 A. M., June 22, and, with everything wide open, reached Diamond Shoal Lightship at 3:39 A. M., June 23, having covered the distance of 570 miles at an average speed of 27.99 knots. Full power was maintained until the "Leviathan" reached latitude 36.52 north, longitude 74.21 west, when it was found that the ship had covered a distance of 687 miles in 25 hours, at an average speed "over the ground" of 27.48 knots—a splendid performance and a world's record for a continuous 25-hour run.

Now it detracts nothing from the merit of this performance to remind our readers that this does not mean that the "Leviathan" is a 27½ to 28-knot ship in still water. To get at her actual speed, we must make a deduction for the speed of the Gulf Stream, in the axis of which she was running, and an addition must be made to her speed to compensate for the loss of power due to the high temperature, 85 degrees, of the sea-water which was passing through her condensers.

A study of the current charts of the Hydrographic Bureau of the United States Navy shows that at this period of the year the Gulf Stream runs at a speed of 3½ to 4 knots off the southerly coast of Florida and diminishes in speed as it spreads out to the northeast. The average speed over the 25-hour course, taking account of the high temperature, was probably about 2.75 knots. Deducting this, we get a speed of about 24.73 knots through the water.

On the other hand, if the speed of the Gulf Stream was a help, its high temperature of 85 degrees was a hindrance to the speed of the "Leviathan." The normal sea temperature is 65 degrees and that rise of 20 degrees played all sorts of mischief with the vacuum—and a high vacuum, be it remembered, is all-important in developing the full power of a steam turbine. With sea-water at 65 degrees the "Leviathan" would have shown at least 28 inches at the condenser, and this



Trial course of S. S. "Leviathan." Full-power run was made from Jupiter Inlet to latitude 36.52 north

would have meant an addition of 0.75 knots to her speed, raising it to 25.48 knots.

If, at the end of the 25 hours, the "Leviathan" had turned and run back over the course, and the same conditions of no wind and calm sea had obtained, the current effect would have been eliminated, and the actual speed would have been determined with great accuracy. This method is used in all our warship trials over the measured mile at Rockland, the vessel being run alternately with and against the current; the mean speed, as thus obtained, being the actual speed through the water.

As a check upon the above calculations, in which the speed of the Gulf Stream is necessarily no more than an approximation, we have available the closely accurate method of determining the speed of a ship by the revolutions of the propellers. Applying this to the "Leviathan," we find that the pitch of her propellers is 14.93 feet, and that the average revolutions for the 25-hour run were 184 per minute. So, 14.93 (pitch) x 184 (average revolutions per minute) x 60 (minutes per hour) gives us the distance the propellers would move through the water in one hour, if the water were rigid. Dividing this by 6080 (one knot) we get the speed in knots per hour. But because of its fluidity the water is driven rearwardly in a variable proportion to the forward motion of the ship. This, subject to certain corrections, is known as the "slip," and experience has shown that, in average weather, with propellers suitable to the ship's form, etc., the slip is about 10 per cent. Making a 10-per-cent reduction, we arrive at an average of 24.39 knots for the 25-hour run.

But the "Leviathan" was using cooling water in her condensers which varied in temperature from 85 degrees at the commencement of the run to 78 degrees at its close, and this had the effect of pulling down the vacuum to as low as 26.5 inches during the first few hours of the trial. Had water been available at 65 degrees it would have been possible to hold the vacuum at 28 inches, as was done in the cool water off Boston at the start; in which case about 0.75 of a knot would have been added to the speed. Thus we arrive at 25.14 knots as the speed of the ship through still water.

From these considerations we are led to the opinion that, in a series of runs, with and against the tide, in deep water, the "Leviathan," when she has been thoroughly shaken down, would be capable of making a speed of 25.25 to 25.50 knots over the measured mile. The "Majestic" (six feet longer and with two more boilers) has averaged 24.79 knots from Ambrose Light to Cherbourg; hence we may look for a spirited ocean contest between these fine ships.

When we bear in mind that the "Leviathan," during the intervening ten years since her launching in 1913, had seen only about eighteen months of service, and that she had spent over eight years lying idle in the water, it will be agreed that the fine results achieved in this trial are a great credit to the Gibbs Brothers, who laid out and supervised, and to the Newport News Company, who executed the reconditioning, and (in all fairness let us add) to the original builders of this fine ship.

Dynamiting Bedrock Over a Subway Tunnel in New York Harbor

DIRECTLY over a subway tunnel under New York Harbor, with only thirty feet of rock between the tunnel and the river bottom above, charges of one hundred pounds of dynamite are daily being exploded without the slightest injury to the tunnel or to the subway trains which pass along its length at frequent intervals. Diamond Reef lies in the bed of the East River, just above the old Brooklyn Bridge, and rises to within thirty feet of the surface at low tide. In order that the largest battleships may pass this point and enter the Brooklyn Navy Yard, as well as to permit the passage of the deep draft vessels now so largely in use in the merchant marine, the channel must be deepened to forty feet. The obstructing reef is of solid rock of a very tough variety, so that before the explosive can work against it to good advantage it must be placed in holes drilled in the rock to a depth of ten feet. This drilling must, of course, be done from a scow on the surface of the water, and it is essential that means be provided for holding the scow rigidly in place when the tides and swells from passing harbor tugs batter it. The scow is equipped with vertical spuds, like a dredge, and these are projected downward until they rest on the bottom. In addition to this, by means of racks and pinions moved by small back-geared steam engines it is possible to raise the scow bodily, not clear out of the water, but some distance above its normal level of flotation. For all practical purposes the scow is now no longer a scow, but a temporary platform on legs and the drilling may proceed with the assurance that the drills will not be thrown out of line above the holes. A battery of three churn drills is mounted on the scow and the holes are sunk to a depth of ten feet on ten-foot centers. The scow or drillboat now backs away about seventy-five feet, the charges of 80 or 90 per cent gelatin are packed into lengths of common galvanized iron leader pipe and these are lowered into the holes.

When the charges have been connected in series by the wires used for electric detonation, the charges are ready to be fired. Certain precautions must now be taken. On broad principles of safety it is necessary to ascertain that no subway trains are in the section of the subway beneath the river. This is made known by a system of electric signaling that was installed for this purpose. Trains are prevented from entering the tunnel and those that happen to be in it are allowed to pass through. Then the signal is given and the charge is fired. Surprisingly, it has been found that so little tremor is felt in the subway only thirty feet beneath the point of the explosions that a glass of water placed on the floor of the tube as a test trembles but slightly.

Psychic Adventures at Home

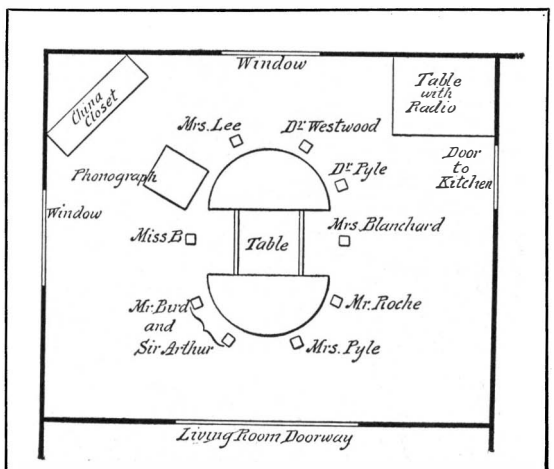
The American Supplement to My European Expedition: A Sitting with Ada Besinnet

By J. Malcolm Bird

Associate Editor, SCIENTIFIC AMERICAN, and Secretary of the SCIENTIFIC AMERICAN Psychic Investigation Committee

WHILE he was in New York in April, Sir Arthur Conan Doyle suggested that he might be able to arrange for me, with some of the better American mediums whom I should have difficulty in approaching directly, a few informal seances of the same sort as my English ones. He was encouraged to do this, and presently I had a wire instructing me to meet him in Toledo on Thursday, April 26, for a sitting with Miss Ada M. Besinnet. Miss B, as I shall call her for economy's sake, is regarded by spiritualists as one of the world's foremost mediums.

The seance was held in the dining room of Dr. John S. Pyle's residence, at 1064 Prospect Street. Dr. Pyle is one of Toledo's leading medical practitioners. He has known Miss B from the age of twelve, and has watched her mediumship develop from its earliest stages, with an interest which seems to be in equal parts friendly, professional and scientific. Of the other members of the group whose names appear on the diagram, special mention must be made of the Rev. Horace Westwood, pastor of the First Unitarian Church of Toledo, who has for some time been interested in Miss B's mediumship and who was one of those who defended her against Mr. Black at this time last year. Mr. W. W. Roche, of the Toledo *News-Bee*, is known to our readers in this same way. Save for myself, in fact, all the sitters were close friends of the medium and fairly frequent sitters with her; so from the spiritualist viewpoint a brilliantly successful seance could be anticipated.



The two chairs bracketed under the names of Sir Arthur Conan Doyle and Mr. Bird were occupied in alternation by these two sitters, who on three occasions during the seance were instructed by the controls to exchange seats. Miss B was the medium

Arrangement of the sitters and the furniture at the seance described in the accompanying article

The party assembled early; Miss B likes a bit of social contact beforehand, to get an atmosphere. The Pyles live in a thoroughly typical detached cottage of the sort found in the outlying residence districts of American cities—"villa" is the word for my European readers. Considerable preparation was involved, in which all hands joined. I watched carefully for evidence that certain tasks were done by certain people, that furniture was placed in particular spots, etc., and found nothing whatever of this sort of suspicious doings.

Miss B requires total darkness. The two windows were sealed by means of dark curtains, fitted close to the glass outside the conventional dark shades. The living room, wide open to the street through a door and numerous windows, could not well be darkened. It joined the dining room through a wide open doorway. The big rug that carpeted the dining room was taken up and hung in this opening. Along one side of the rug was a series of loops, with nails to match along the wall above the frame of the doorway. The rug was adjusted with complete success, cutting off all light from the front of the house. I was informed that while seances had been held at the Pyle house before, they are by no means so frequent as this preparedness might lead one to suppose.

The dining room contained an extension table, a smaller table in one corner with a vacuum-tube radio outfit on it, a large china closet, and a cabinet phonograph. Of these articles, only the phonograph was moved from its permanent place. The dining-room chairs were supplemented from other rooms.

Miss B's controls demand a "solid" table. The extension table, whether the leaves be left in or taken out, has one or more joints which violate this requirement. So it is opened as though several leaves were to be inserted, and the operators accept this as the equivalent of two separate "solid" tables. The medium then sits, not really at the table at all, but at the opening in the table. Obviously this would give her better access to all parts of the table and circle than she would have with a more conventional arrangement. The extent to which she could circulate in and out of the well in the center of the table is, of course, entirely problematical. The "runners" along which the table slides and which hold the two ends together would hinder this in some ways, and I suspect in others they would facilitate it.

Miss B has phonograph music throughout her sittings; and since her controls insist upon their familiar and favorite airs, she carries her own records with her—she even carried them to England. Their unpacking was delegated to me. From a large suitcase I removed some fifty large and small records of the disk type, two tambourines, a sectional trumpet of cheap leather or heavy cardboard, a writing tablet, a pencil, and about ten yards of rope in two pieces. All this was piled indiscriminately upon the table; then Miss B sorted the records out into three groups—vocal, and loud and soft instrumental.

The phonograph was at the medium's left, where there was barely room for it between table and china closet; it seemed an effective barrier against her moving about in that direction. The privilege of tending it during the seance was offered me, and declined on the ground that it would take too much of my attention. On the whole this was a wise decision, but there were moments when I wished I were at the machine, and in a series of sittings I should take this position at least once. The duty was finally assigned to Mrs. Lee; the rest of the company sat as diagrammed. There was no physical obstacle against the medium's moving about to her right, but Sir Arthur and I observed no evidence that she was ever doing so.

Miss B's controls are two in number: Pansy, a little girl, and Black Cloud, the inevitable Indian. Pansy speaks in a lisping childish tone; Black Cloud throws in two or three words at a time in staccato grunts. Both are apt to rap instead of speaking, if what they have to say is covered by the code. Like a good Indian, Black Cloud is hard to amuse, but he finds white squaws more to be laughed at than the generality of things; and he laughs at them by gently shaking the table.

Hands were placed, flat and unjoined, on the table, and we were insured that the controls would rearrange them whenever they wanted them rearranged. The white lights were replaced by a single red bulb, this was extinguished, and the seance was on. At intervals, one of the sitters would ask, "Are you here, Ada?" After perhaps five minutes the question failed to elicit an answer; so someone asked "Are you here, Black Cloud?" The answer was "Yes," in very faint raps.

Before the medium was thus marked as having gone under, lights appeared, quite bright and of considerable range and speed of travel. I was told that this was usual. After the controls had taken charge, the lights continued for some time to be the only phenomena; but presently we began to get vocal effects. These were confined to singing and whistling. A tune or a song might be played through on the machine without incident; but always there was the prospect that the whistler would join the tune, or any one of numerous singers would add their efforts to the song.

These voices were altogether extraordinary. They came clearly from the well in the center of the table. On one occasion the large end of the trumpet was presented for me to put my ear to, verifying that the voice was not in it; and most certainly it was not. Without exception the voices had the touch of personal characteristics; thus, one female voice had a distinct Irish lilt. There was a prodigious rich tenor, sufficient in volume to fill a cathedral. This particular singer has a name—he is Dan, and he attends all Miss B's sittings. Collectively the voices ran the gamut of the piano range, from the tinkliest treble to the deepest and most goose-fleshy bass. Even if one were prepared to believe that Miss B could produce Dan's colossal voice, one would stumble over the assumption that one person could have such a range. And I have never heard a tune carried so well by any other whistler as tunes were carried by the whistle that came from the center of the table.

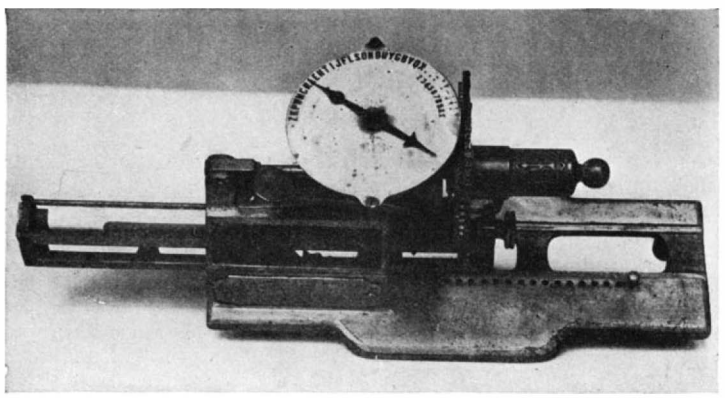
Mrs. Lee had the phonograph records piled before her, and it was her duty to keep the machine wound and supplied with records. On the second or third record attempted, the music was cut off immediately it started. Mrs. Lee denied having done this; Black Cloud explained, in answer to questions, that he wanted a softer record. Throughout the seance when a record was stopped, the motor wound, the lid raised or lowered to alter the volume, or a record put on or taken off, Mrs. Lee would state whether she had done it or not. Usually when she entered a disclaimer, Dr. Westwood was able to assert that he was in contact with both her hands. Quite usual was stoppage of the machine and rejection of a record that had been put on without consulting the controls to see which sort of record they wanted. Once we had something fairly evidential; the motor was wound "independently" when the medium was clearly marked by contact with me as being in her seat. The handle was on the side away from her, and it seemed unlikely that she could reach it, or having distorted her arm to reach it, turn it.

Toward the end of the seance we got trumpet voices on a small scale. The trumpet would be presented directly to a sitter, and the message given in a whisper that was quite inaudible to the others, and almost so to the one addressed. There was also a performance with the tambourines. One of these had a spot of luminous paint, by virtue of which one could follow it as it travelled about above the table, in and out over the heads of the sitters. While thus travelling it played an accompaniment to the phonograph tune; one of the ladies remarked that she had not realized that such good music could come from a tambourine, and I was inclined to agree. The tambourine and the lights in their travels covered space above the center of the table, to which it was difficult to see how the medium could take them by hand without getting tangled up in the lamps and arms of the chandelier.

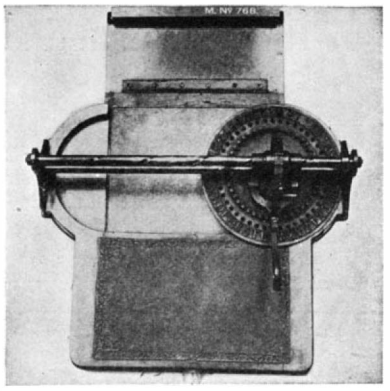
While this medium does not sit tied as does Powell, the ropes play a part in her performance. The control announces that the medium is to be tied, and after an interval of five or ten minutes requests that the red light be turned on and the work examined. The medium is found in apparent trance, with her hands

(Continued on page 211)

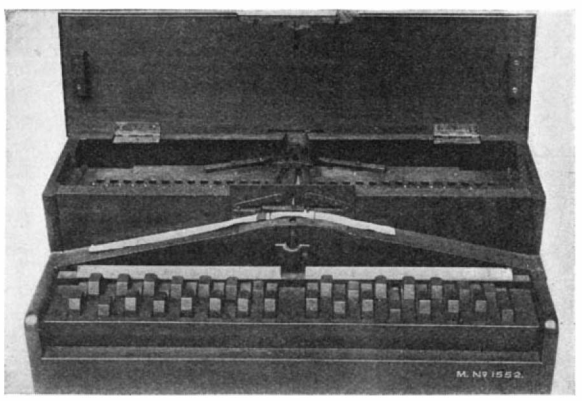
MORE than once we have pointed out, in a place like the present one, the distinction between Mr. Bird's personal and informal examination of mediums, and the formal tests carried out by his committee. Heretofore, there has been a geographic basis for the distinction, in that the informal work had all been done in Europe and the formal sittings held all in America. With the present instance, this geographic barrier is broken down; we have Mr. Bird holding an informal seance with an American medium, in America. It therefore becomes doubly important to insist, as he has done, upon the fact that this sitting was not given in the presence of our committee and has no standing with them. Miss Besinnet has not even expressed a willingness to sit with them, in fact, so the reservation must be made on her behalf as well as on ours.—THE EDITOR.



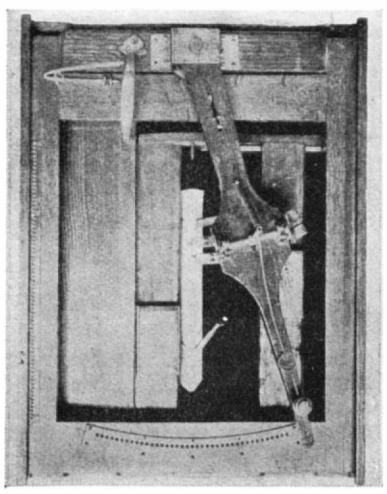
Introduced in 1836: A Columbia typewriter of dial form, with 72 characters on the edge of a vertical disk or wheel



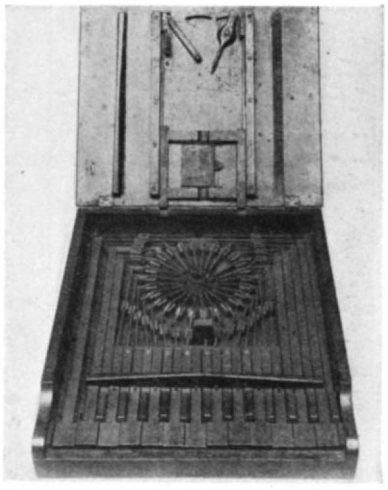
Invented in 1850 by S. A. Hughes: A typewriter for the blind



Designed in 1851 by Sir C. Wheatstone for the rapid printing of telegrams: A typewriter with a piano-like keyboard

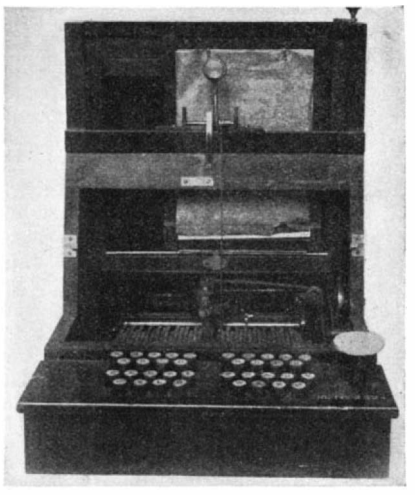


Now in the National Museum at Washington: The Burt Typographer of 1829

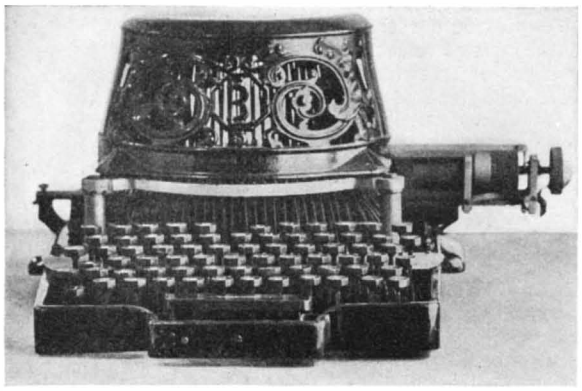


An early Pratt typewriter of 1865, preceding the Pratt typewriter of 1866

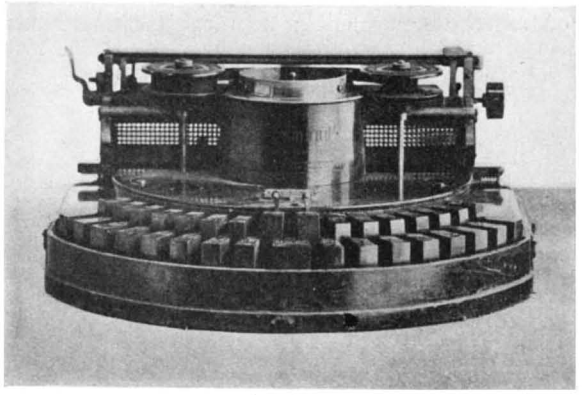
Patented in 1873: The Remington (originally known as the Scholes-Glidden)



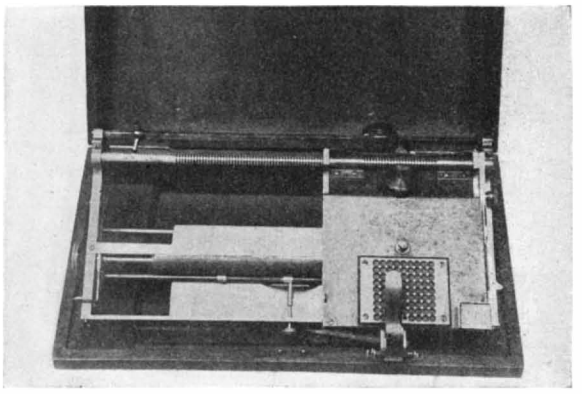
Made and patented by John Pratt in 1866, with 36 symbols on a vertical roller



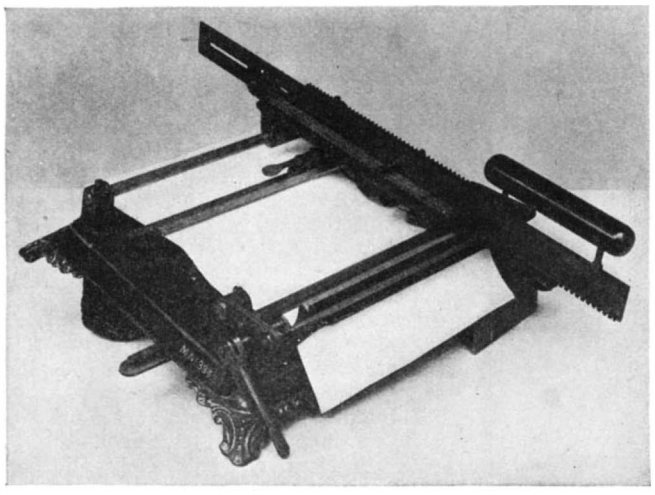
Patented in 1880: The Bar-Lock typewriter, No. 1 model, resembling certain types of present-day machines



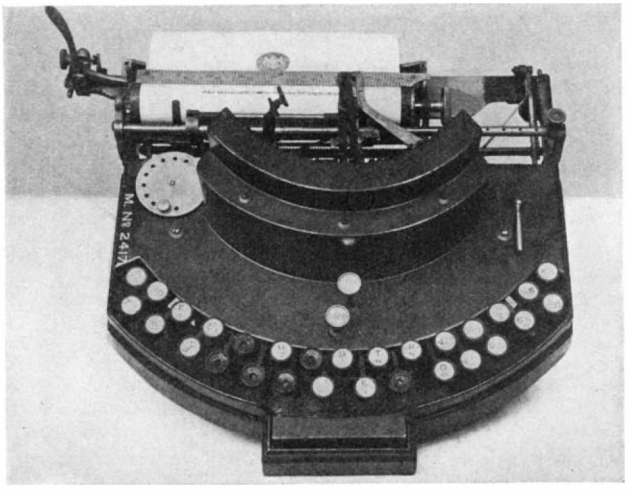
Once the property of Sir Henry Irving: A Hammond typewriter patented in 1880. The type is on a segment bar



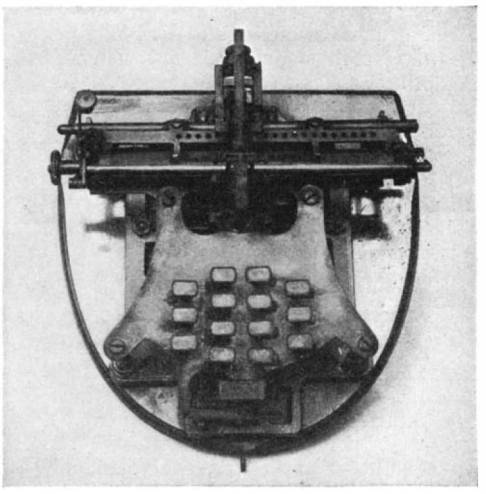
Patented in 1881 by Thomas Hall of New York: The Hall typewriter, with square rubber sheet as fount



Patented in 1884 by A. H. Guhl: The "Hammonia" typewriter, with 45 characters on the edge of a thin straight blade



Made in 1890: A machine lent for exhibition by the English Typewriter Company, with 29 type-bars arranged in an arc



Patented by J. Gardner in 1893: A machine meant to reduce size

THE typewriter in practical form, is fifty years old. The earliest reference to a writing machine is the recorded invention of an Englishman named Mills, who is said to have patented a typewriter as long ago as 1714. The first salable machine, however, was the work of two Americans named Scholes and Glidden, who, after some thirty attempts, had a typewriter placed on the market by a firm of gunmakers in 1873. This was the foundation of the typewriter industry. Another American named Soulé devised the pivotal type set in a circle. The shift key for using a capital as well as small letter on each type-bar was invented in 1878, and other improvements followed until the typewriter as we know it today was evolved. We are indebted to the *Illustrated London News* for the accompanying excellent illustrations.

SOME MILESTONES IN THE DEVELOPMENT OF THE MODERN TYPEWRITER

Keeping the Ash in Motion

Continuous Mechanical Discharge of the Unburned Residue, and Its Role in Boiler Efficiency

By David C. Spencer

ONE of the problems which constantly confront boiler room engineers and operators, is the matter of cleaning fires and discharging the ash. To the average layman, this may seem like a simple proposition. In the case of small furnaces where operation is carried on at nominal rating or less, possibly the situation is not so difficult. But in these days of large units and continuous operation at high overratings, the problem assumes an entirely new aspect.

Boiler operation may be classified in two groups. There is the station or plant whose load changes frequently, sometimes slightly, at other times in violent swings. The boilers may be delivering steam at 100 per cent of rating at one minute, and five or six minutes later be required to deliver 200 or 300 per cent of rating, with an equally sudden drop when the load goes off. Such experiences are not infrequent in central-station practice or in such industries as pulp and paper mills, rolling mills, power stations of coal mines, etc.

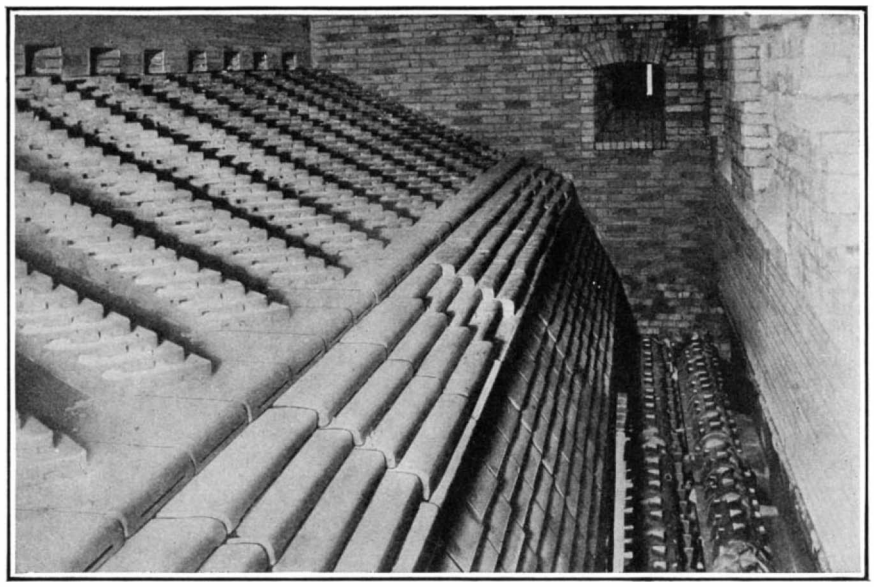
Then there is the station whose load is fairly constant for an extended period of time. Such changes as occur are gradual and can usually be anticipated. There are practically no sudden fluctuations. Instances of this class are found in the case of power companies operating two or more stations, one of which carries the swing, while the others operate at a uniform rate. Among industrial plants a good example would be a shop equipped with machine tools or a spinning or weaving mill where production is fairly steady.

In stations of the first classification, the operator's problem is to deliver steam when and in the quantity, that is required by the plant processes. In the case of central stations supplying light to the community and power to the traction lines, a sudden storm, for example, means an instant increase in both the lighting and power load. This increase must be met and carried by the boilers. In the industrial field the sudden call for steam for process purposes, as for example vulcanizing in the rubber industry, means an equally sudden peak which the boilers must take. The operator's problem in such cases is, as has already been stated, to deliver the steam. To accomplish that he must have an equipment that is highly flexible.

The elements which make for flexibility are the reserve capacity of the stoker and the ability to clean the fire quickly, easily and thoroughly, and that the cleaning period should be variable at the will of the operator. The reserve capacity of the underfeed stoker is so well known as to call for little additional comment in this discussion. Suffice it to say that the multiple-retort stoker with its deep fuel bed provides in the greatest degree the first essential element.

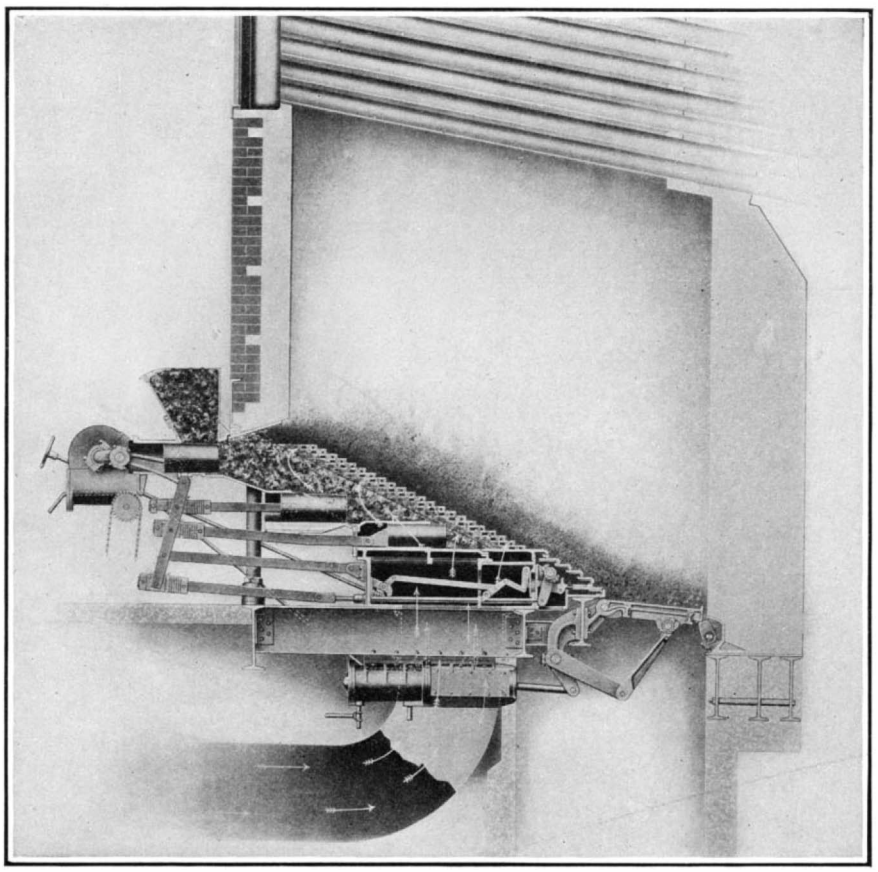
The power dump is without exception the most satisfactory method of cleaning fires where conditions exist such as have been outlined. It gives the operator absolute control over his fire. He can, if necessary, increase the rate of coal feed to meet almost any contingency that may arise. Every operator knows that the question of capacity is largely one of the amount of grate area that can be installed under the boiler. Temporary operation of 500 or 600 per cent of rating is not beyond the point of possibility, provided the boiler can be stoked up to that point. But it would probably be uneconomical from a good many points of view because so seldom required.

The same output, however, can be temporarily attained with a much smaller stoker if the operator feeds the coal in at a high rate, burning off the volatile and discharging a large proportion of the coke. Naturally this would be very wasteful operation, but when the operator is confronted with the necessity of delivering a certain amount of steam or facing a shutdown, probably it would be the less wasteful course to pursue. Of course, this is an extreme case. A capable operator seldom gets caught in a jam which would require operation of that character. But he frequently finds himself under the necessity of increasing his steam delivery 50 to 100 per cent or more without warning. Under such circumstances he must put more coal through the stoker even though by doing so, he may lose a considerable amount of unburned carbon.



Stoker in a Philadelphia power plant fitted with two-roll rotary ash discharger

As has been said, the power dump is probably the most effective method of cleaning fires to accomplish this purpose. It provides a variable rate of ash discharge that functions at the will of the operator. It requires the minimum amount of time to drop the dump plate, so that the accumulation thereon may fall into the ash pit, and return the plate to its normal running position. A glance at the accompanying drawing will show why it is easily possible to perform this operation in less than half a minute. It is especially noteworthy that in such operation with the power dump, there is practically no interruption to steaming as the result of the dumping period.



Cross section of mechanical stoker equipped with power dump for ashes. The arrows show the direction of air circulation

In the second class of operation the problem is entirely different. With a fairly constant load, the operator seeks, naturally, to operate his plant at the point of maximum efficiency. There is comparatively little need for the ability to clean fires instantly. Rather, there is urgent need for as nearly as possible clean fires at all times. The ideal way to maintain clean fires is to discharge the ash as rapidly as it forms—in other words, by means of continuous ash discharge at a rate proportional to the rate of combustion.

The most practical and satisfactory device for accomplishing this result is the rotary ash discharge which has been brought to a high state of perfection. One of its essential features is a deep ash pocket. This pocket must not be regarded as primarily a storage place for ash. If that were the only requirement, an ash pit would probably answer the purpose.

It is extremely difficult to handle hot ash. After the ash has become cool, it can readily be broken up and discharged. The ash pocket serves as a space in which ash may be treated or conditioned for discharging. The conditioning of the ash involves the final burning out of any combustible which it may contain after it leaves the stoker proper, and the cooling of the refuse.

To provide for this the ash pocket is divided horizontally into two sections. The upper section is flanked by a grate somewhat similar to the extension grate of the stoker itself. This is provided with ports through which air may be admitted in any desired quantity. The combustible which remains in the ash after it reaches the pocket continues to burn while in this section and this results in reducing to a minimum the combustible in the final residue and, therefore, in increased combustion efficiency.

The lower portion of the pocket is flanked by cast iron crusher plates. These provide a surface against which the clinker can be crushed. In all double-set arrangements of the stoker there are crusher plates on each side of the pocket. This is also true of single set arrangements where two crusher rolls are provided. When only one crusher roll is used, the crusher plate is on the stoker side of the pocket and the bridge wall side is lined with a rigid cast-iron plate.

The crusher plate is movable so that the gap between the plate and the roll may be adjusted to any desired width. This provides for crushing the clinker to any size suitable for easy handling by any ash disposal system. It also permits a certain degree of variation in the rate of ash discharge although this is a secondary function. Finally, it provides a means whereby the ash pocket may be emptied when the stoker is off the line for cleaning or overhauling.

The crusher rolls are the operating element of this system of ash discharge. They consist of cast-iron shells mounted on a steel shaft which has a square cross section. The shells are built up in sections for convenience and are armed with teeth that have a triangular cross section. These teeth are made of special cast iron which is very durable and are made removable for ready replacement. The design of the teeth is such as to provide the maximum crushing force with the least strain on the rolls or mechanism.

The rolls may be operated by the stoker drive or independently as desired. In either case provision is made for varying the speed of the rolls independently of the stoker to regulate the ash discharge rate.

Ventilating an Existing Tunnel

SO great has been the increase in motor vehicle traffic in American cities that those which have street tunnels are finding in many instances that a new and serious problem has been created. The exhaust fumes from motor cars are not infrequently the occasion of much annoyance in busy city streets and even cause serious discomfort when wind and weather conditions are such as to cause the fumes to accumulate. But far more serious is the accumulation of motor fumes in traffic tunnels. These bores were originally constructed when automobiles were few or wholly unknown. With the advent of the gasoline engine and the resulting increase in the number of vehicles on the streets many tunnels have become traps for fumes which in some cases have actually endangered the lives of persons passing through these bores.

So serious has the problem become in Los Angeles that it has been necessary to sink two perpendicular ventilating shafts from the top of the hill through which the city's most used tunnel passes, so that by means of electric fans the foul air in the underground passageway can be drawn off. By this means the air is changed entirely every few minutes. One of these shafts is 42 inches in diameter and the other one approximately 18 inches.

The problem of how to dig or drill these ventilating shafts proved an unusual one when the city engineers started out to find a concern that would undertake the contract. The task was different from the ordinary run of drilling or digging jobs and the authorities were somewhat at loss to find men competent to undertake the work. The most practical way seemed to be to drill the hole from the top of the hill to the roof of the tunnel with some kind of well-drilling apparatus, making the bore as large as possible. Accordingly, a driller of oil wells was hired who drilled the smaller of the two holes already mentioned at what was conceded a reasonable figure. Before he had finished his task, however, the work attracted the attention of a man who owned and operated a manhole digging machine. His equipment was entirely different in character and by means of a rotary digger he was able to sink a 42-inch shaft at no greater labor than that with which the driller could sink an 18-inch shaft. Accordingly, the contract for the second vent was transferred to the manhole digger, who has completed his half of the task at a figure a little lower than that charged by the well driller. Under all the circumstances and in view of the unusual character of the undertaking the city felt that both men had earned their money.

Left: Street view showing east end of the Third Street tunnel, Los Angeles. One of the new ventilating ducts is close to the observation tower. *Right:* Sinking the 42-inch ventilating shaft, 90 feet deep, with the use of a manhole digger

Los Angeles' street tunnel, designed in motorless days, has had to have ventilating shafts added to take care of the exhaust gases from automotive traffic

The improvement in the way of two vents with electrically operated fans has proven highly satisfactory and the much used Third Street tunnel, which is nearly a fifth of a mile in length, is now filled at all times with clean, wholesome air. Formerly when there was little wind and traffic was heavy the bore contained such dense fumes that pedestrians found it almost impossible to make their way from end to end.

The Use of Paper in Gardening

WHILE the use of paper for many useful purposes in gardening, raising flowers and vegetables, may not be new, nevertheless the advantages, which may be gained by such practice, are not generally known. Most people know that paper is a good heat insulator, that is, it is a very poor conductor of heat. Hence, when an object is enveloped in paper, its inherent heat is prevented from being rapidly dissipated and at the same time the cold or hot air, surrounding the object, is prevented from coming in contact with it and either detracting from or enhancing the heat contained in the body.

It is this property of paper that makes it so useful in gardening. Furthermore, while ordinary paper is non-transparent and non-translucent, when the paper is oiled, it will allow light to pass through it, and at the same time it will be effectively waterproofed. This fact is also of importance in rendering paper applicable for many purposes about the garden and the greenhouse.

Actual practical experience has shown that it is possible to obtain effective protection for young seedlings and tender plants against the inclement weather of winter and early spring by the use of paper. Instead of employing expensive glass for the windows of frames and greenhouses, oiled paper may be used with just as good results and in fact, if taken care of as conscientiously as glass, they will last just as long. Of course, the cost is very much less. It must be mentioned that such oiled paper lights may be exposed to the weather as much as possible and still possess long life. Another saving is in the construction of the frames, which need not be nearly as heavy as when glass is used.

The use of paper for this purpose is not in any way universal, but it is due simply to ignorance of the effectiveness and the cheapness of the material. In France, where intensive cultivation of vegetables is carried out to a far greater degree than in this country, the value of paper for making the windows in hot house frames has been appreciated for some time past and paper is largely used for this purpose in that country. Very good results have been obtained in the use of oiled paper for covering pits in which there were stored surplus chrysanthemums, tender shoots and similar plants that must be protected in green houses during the cold winter months. When the seedlings first send up their shoots above the ground, it is often necessary to shade them from direct sunlight. In this connection it has been found that the diffused light which penetrates through oiled paper is particularly well suited to them, and the shades, which must be erected when glass frames are used, are unnecessary in this case.

Old newspapers have been put to many purposes. They sometimes serve to protect the person against cold in lieu of an overcoat. The same property, which renders them useful for this utilitarian purpose, makes them a very effective protection against cold for tender plants. In the early spring, when frost may still appear on the ground over night, it is a wise gardener who covers up his plants with newspapers as the evening sets in and does not remove them again until all the frost has disappeared the next morning. If this is done regularly and conscientiously, no fire heat at all is required, thus simplifying matters and saving money.

It may be mentioned that when newspapers are used as protection against frost, it sometimes happens that one forgets to use them a certain day and the next morning the plants are frozen. Heroic means must then be taken to bring them to life again. The best thing to do is to spray them with ice cold water before the sun is up and to protect them against the sun's rays with paper covering for some time thereafter. The remedy is drastic but sound.

An instance is cited of a large hot house full of cinerarias, which were completely frozen over a certain frosty night due to the heating apparatus going out of order. The plants were quite black and apparently ruined, but were brought back again without any ill effects by means of the above treatment.

"Only a Little Trickle—Let It Run"

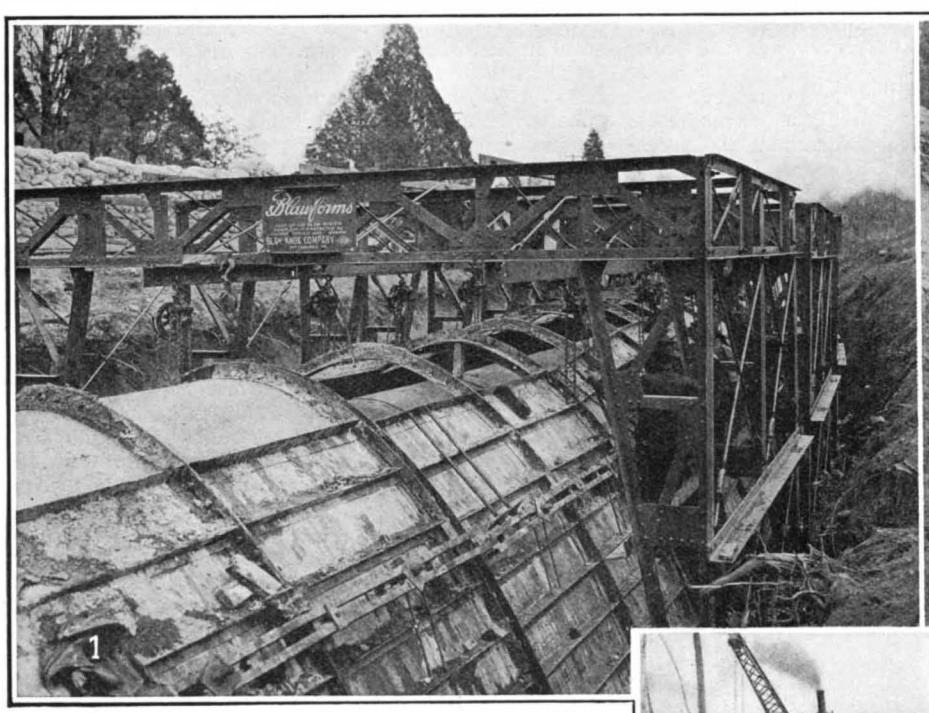
THOSE best qualified to express an interest in waste of water are those who have the bills to pay. It is in communities where water is not metered that waste is most apt to be ignored, but in the long run the waster pays the bill. To enable the average person to visualize the amount of waste that can result from leaving tiny streams running, a Mattoon, Ill., maker of water-works equipment has issued a pocket piece resembling a twenty dollar gold piece. This will assure its attention at the start. Of three tiny holes which are bored through it, the largest is only one-eighth of an inch in diameter, yet the pocket-piece bears the legend that in a day of 24 hours, 3600 gallons of water would be wasted from an opening of this size. Another hole which will not permit the insertion of a pencil lead is stated to be the potential waster of 960 gallons per day; while a third hole just large enough to receive a pin is nevertheless large enough to permit the flow of 180 gallons or over 3½ barrels. This corresponds to about 140 cubic feet per week.

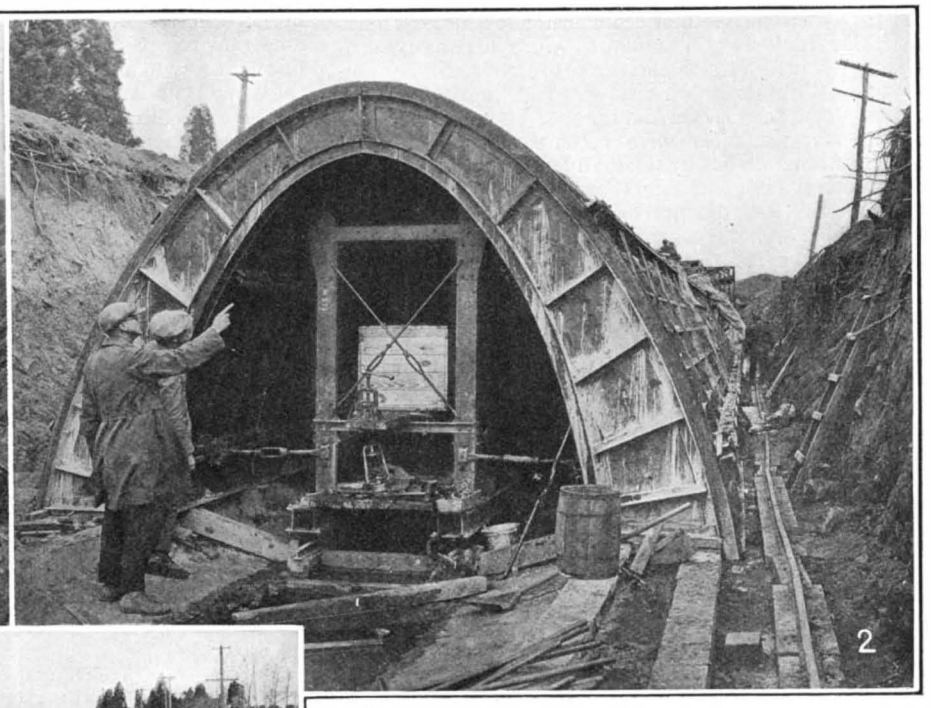
The figures given are for a head of 40 pounds. Higher pressures would increase the waste, though not in direct proportion to their values. The next time you see a tiny leak, remember that it is capable of making a larger dent in the purse than appearances would indicate, and do not be surprised if a rigid inspection of plumbing is carried out at times when a water famine is a possibility.

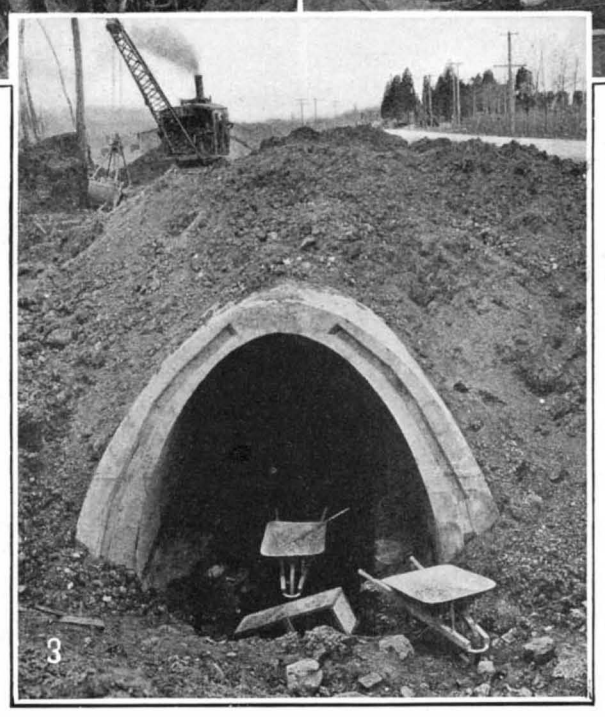
More Water for Washington

The Great New Conduit that Will Double the Capital City's Supply

By George H. Dacy







1. The mechanical traveler that moves the forms from section to section after the concrete has hardened. 2. A temporary track inside the conduit carries miniature cars that support the interior metal forms. These forms, too, move forward with the work, pulled by rope cables. 3. Groove in the end of a section, to take the asphaltic joint

Some details of the work on Washington's new water-supply conduit

IN ORDER that Washingtonians may have plenty of water to drink—the City of Presidents has been menaced by a portending water famine for several years—Uncle Sam is building a large new water conduit that extends from Great Falls, Md., to the boundary of the District of Columbia where a new model filter plant will be installed. Away back in 1856, the first conduit, a circular brick tube nine feet in diameter and nine miles long, was constructed to carry the water supply of our National Capital from Great Falls to the Washington consumers. This sanitary water channel or tunnel was one of the great engineering feats of that day and age. Subsequently, a permanent government road was built directly above the mammoth pipe line. Entrances to the conduit were provided at intervals of approximately 1000 feet.

All went well and the city of Washington was blessed with a superior and abundant water supply until about a decade ago when our most beautiful American city began to grow and attain the dimensions of a world-wide capital. The population increased very markedly. With the advent of thousands of more thirsty consumers, the water supply began to be inadequate. Now with a population of more than 438,000 permanent residents, with untold thousands of transients thronging into the Federal capital daily, the 24-hour water supply of 100,000,000 gallons is insufficient. And, peculiarly enough, the consumers use more water during the winter than during the droughty, hot and muggy months of summer, probably due to the fact that many let their water run constantly to keep the pipes from freezing. Conditions are such in our Capital City that sanitary drinking water has to be used in washing the streets, sprinkling lawns and extinguishing fires.

A new concrete conduit is now under construction which parallels the route of the old conduit. No more convincing evidence of the revolutions that have been worked in engineering and construction operations is to be had than to contrast the systems of building employed in installing the old conduit and its new supplement. Admittedly, the work of more than a half century ago was excellent. It has withstood the onslaughts of time, and well served its purpose. A product of an era of cheap hand labor, the old conduit has been efficient and durable. Modern engineering, however, is doing now in weeks what it took many months and even years to consummate during the period prior to the War of Secession.

The concrete pipeline now under construction is 10 feet high and 10 feet wide, being of horseshoe form. Whereas the conduit now in use has a cross-section of about 60 square feet, its concrete counterpart is approximately one-quarter larger. When completed, the twin pipelines will have a combined carrying capacity that will practically double the existent Washington water supply. There will be the additional beneficial feature that potentially if either of the conduits need repair, such a one can be temporarily put out of commission without putting the District of Columbia on short rations.

The concrete conduit is being laid in 80-foot sections, the facilities being such that one of these sections of concrete can be prepared daily. Extraordinary metal forms are used which take the doubt and danger out of concrete work and which immeasurably expedite the work. The excavation is accomplished by the use of powerful steam shovels—mechanical diggers that have eliminated the arduous hand toil from trench work. After the trench is properly prepared, the concrete base of the conduit is laid in place—this foundation is 10 inches thick, the wall of the conduit pipe being smallest at the base point. The walls are 34 inches thick at their base point and 12 inches thick at crown of the arch. In the neighborhood of 100,000 cubic yards of concrete will be used in the building of the nine-mile conduit, the mixture being a one, two, four combination.

Two lines of temporary steel trackways are installed when this concrete foundation is set thoroughly. The inner tracks provide transportation facilities for a series of small cars that are equipped with turnbuckles and powerful jacks that govern the raising and extending or lowering and collapsing of the interior metal forms that hold the concrete in place. Briefly, these metallic forms, which strikingly simplify concrete construction of this character, can be moved about on the midget cars that run on the inner trackway. When the time comes to move the interior forms, they are lowered by means of the jacks and loosened by use of the turnbuckles. Cables are adjusted properly and hitched to a gasoline tractor that runs along the roadway above the trench, and acts as a steel horse to haul the steel forms to the next position of setup.

The other pair of steel tracks extends along either side of the conduit and provides passageway for the exterior forms which are hung on a special traveler that will convey them to the next point of construction. Turnbuckles and hoisting devices are used to raise and widen the exterior metal forms after the concrete has been poured and set sufficiently for such operations. Altogether, the national engineers are using three sets of these mammoth metal forms which cover a stretch of 240 feet. They pour the concrete in the last form of the train first so that by the time they are placing the concrete in the third form, the first one can be moved to a position 240 feet farther down the trench. This arrangement eliminates any cessation in the work in order to wait for the concrete to set. The exterior forms are moved to new positions in the same way as the interior ones by hitching them to the tractor and hauling them to the new section of construction. After the concrete of the conduit has hardened sufficiently, a steam shovel is used to fill in around the huge underground waterway. The trench is partly filled with water as the earth is dumped into place so that it puddles and compacts as desired without any additional man labor.

In excess of 465,000 cubic yards of earth will have to be excavated before the concrete conduit is completed about June 30, 1924. The cost of the subterranean tube will be more than $2,058,000. In the rocky region fringing the Chesapeake and Ohio Canal and the Potomac River, great difficulty has been experienced in cutting the ditch for the pipeline. Over one stretch of two miles, the cut has been made through solid rock and has ranged from 10 to 60 feet in depth. At Cabin John, Md., where is located what was formally the largest masonry arch in the world, but which is now surpassed by one built latterly in Germany, a huge concrete-and-steel siphon will be installed to carry the water through a gap that is 550 feet wide and 104 feet deep. The siphon will consist of a circular steel pipe ten feet in diameter, which will carry an interior coating of concrete six inches thick, as well as an outside overcoat of the same material that will be 12 inches thick. Two tunnels will also be cut at as many hilly sections of the route that will aggregate 3000 feet in length, for inspection and possible repairs.

Protecting a Beach From Erosion by Ice

THE extent to which lost motion and labor can be saved by planning is shown by a piece of construction which the writer did with his own hands unaided in ten days' time. The job consisted in the construction of a concrete sea wall to protect the beach in front of his home in Northern Michigan from the ravages of the yearly spring ice flow.

The wall was of trapezoidal section, 3 feet 6 inches thick at the bottom, 12 inches thick at the top and 3 feet 6 inches high. The lower 18 inches of height was under water. The essential points wherein labor was saved lay in:

1. The use of a single section of non-collapsible form, which was set and filled one day, and moved ahead and filled again the following day. This form was weighted in place by two rocks, not being nailed; so that no wrecking and rebuilding was necessary. The rocks were simply removed, the form lifted slightly to loosen it and pulled ahead by hand into its new position.

2. No gravel was mixed with the mortar. Dry stones graded in size from that of a hen's egg to that of a man's head were placed in the form. A very liquid mortar of sand, cement, and sufficient lime to insure fluidity, was then mixed with a hoe in a mortar box and dumped into the stones, where it flowed down, filled all the interstices and bound the whole together into a solid mass. Thus about 60 per cent of mixing labor was saved, beside making it possible to substitute the relatively easy hoe mixing for shovel mixing.

3. Sand dug out of the trench for the wall was thrown directly into the mortar box, ready for mixing, without any further handling.

4. The mortar box was supported directly over the wall, so that by simply removing a movable end, the mortar ran by gravity into the forms.

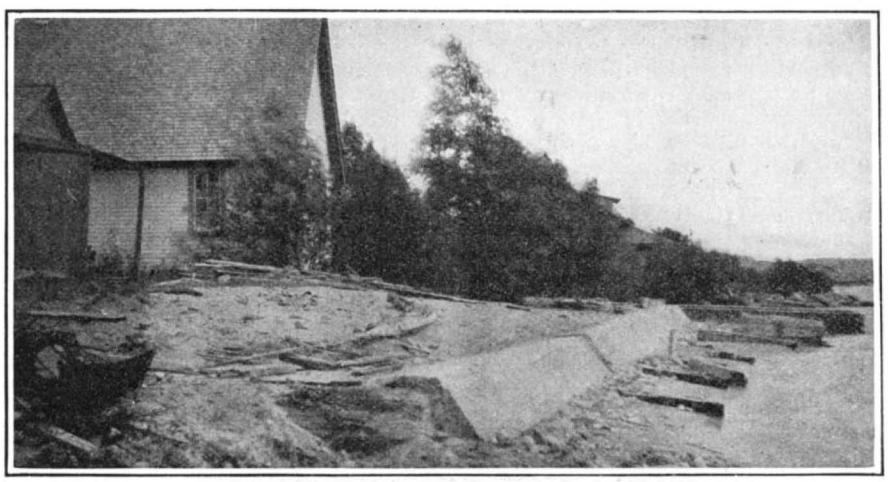
The wall was poured in sections, and only half of the height poured at one time, the upper half of one section being poured at the same time with the lower half of the following section. Thus 7 feet 6 inches of wall was completed each working day.

In the morning a row of light sheet piling was driven in front of a section of wall to keep the waves from dashing into the work. The sand was then excavated to a depth of about 18 inches below water lines, and a layer of old plank laid on the bottom and weighted down with rocks. The form for the lower part of the wall was then moved ahead, placed on the plank floor and weighted into place. The form for the upper section of wall was moved ahead on to the lower section poured the preceding day.

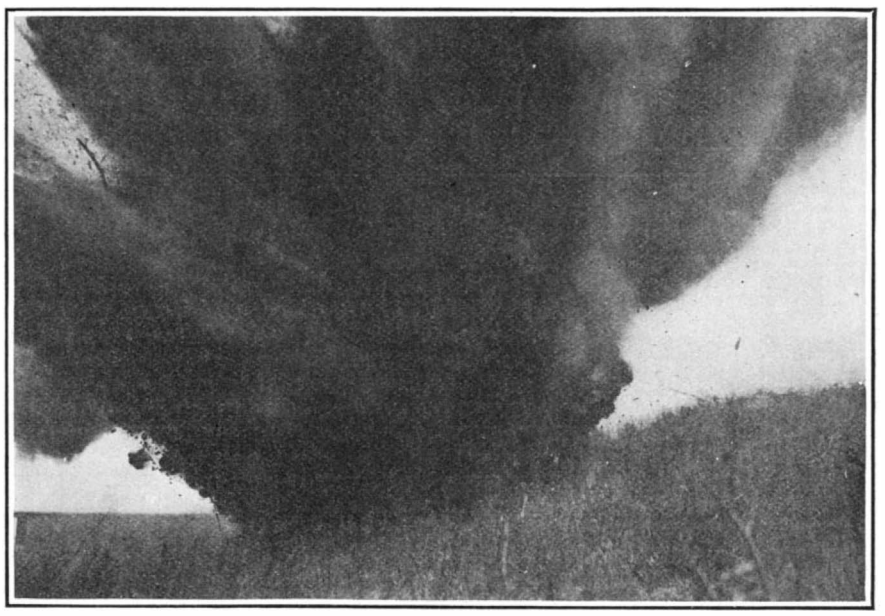
In the afternoon, both forms were filled with rocks placed by hand, and the grout sufficient to fill the voids between the rocks was mixed and poured. Usually two batches would do this. There was usually a little time remaining in the afternoon, which was given to finishing the surface and painting with a waterproof cement paint.

The wall was also tied together longitudinally by several second-hand light-weight railroad rails which were purchased from the owners of an abandoned mill nearby, and which were placed by hand in the forms before locating the rocks around them. Four of these were bedded in the wall for its full length. The space behind the wall was afterward filled solid with sand and boulders hauled in by a local farmer.

The prevailing wind is diagonally toward the beach; and there is a continual drift of sand along the beach by reason of this diagonal motion of the waves. After building the wall, the writer conceived the idea of placing obstructions in the way of this sand drift to hold it and build a beach outside the wall, making things additionally secure. He drove a few lines of sheet piling just outside the wall, and transverse to it, projecting a few inches above water. The result was that in a couple of weeks a strip of beach from six to eight feet wide was made outside the wall. The first season's use has shown this to be a thoroughly satisfactory protection; the sloping front face of the wall deflecting the ice upward and breaking it up as it floats inshore.



The owner of this bungalow has temporarily checkmated the spring flow of ice in the lake, which threatened to scour his property off the map



This blast was produced with charcoal, impregnated with liquid oxygen

Liquid Oxygen as an Explosive

LIQUID oxygen is produced commercially by the fractional distillation of liquid air. The latter substance, just like the ordinary atmospheric air, contains 21 per cent of oxygen and 79 per cent of nitrogen. The nitrogen is more volatile, and evaporates more rapidly than the oxygen. Taking advantage of this, apparatus has been designed for evaporating all the nitrogen out and leaving the liquid oxygen. This is cheaper than condensing free oxygen, because it avoids the expense of getting the free oxygen in the gaseous state, free from impurity.

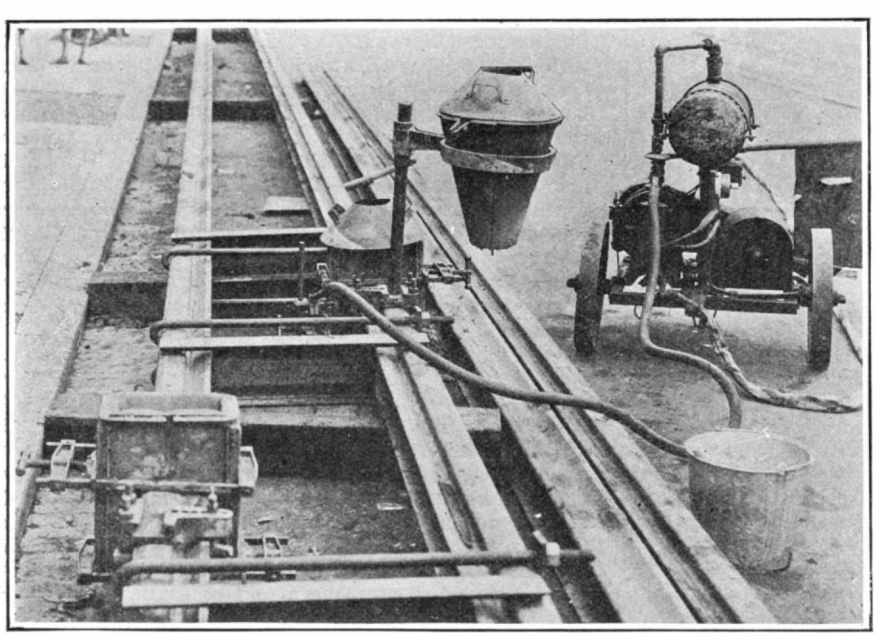
Among the interesting possible applications of liquid oxygen, one is as an explosive in connection with charcoal. Wood charcoal at zero Centigrade will absorb 18 times its volume of gaseous oxygen; at the temperature of liquid oxygen it will take up 230 volumes instead of this mere 18. The charcoal thus impregnated burns with such extreme speed as to give violent detonation.

The explosion pictured was produced by liquid-oxygen-impregnated charcoal, using home-made methods exclusively. The charcoal was finely powdered and placed in a linen sack, 3½ inches in diameter and 15 inches long, to the end of which was fastened a dynamite fuse without any percussion cap. A hole was prepared under a 14-inch stump; and after submerging the sack of charcoal in liquid oxygen for about two minutes, it was placed hastily in the hole, tamped, and the fuse lighted. The explosion was similar to that of dynamite. The stump was entirely removed and the roots so shattered that it would require very little additional work to remove them, while it seems that after using dynamite the stumps are often merely split without removing them.

It is suggested that liquid oxygen can be made at a price to compete with other commercial explosives. Other substances, such as cork, salt, sawdust, etc., may be used in place of charcoal.

Laying Rails 420 Feet Long

WHILE engaged in relaying track, the street railway line in Washington, D. C., recently adopted an unusual method of welding and installing its rails without interruption to traffic. The rails to be installed were laid along the side of the street parallel to the track, welded together during the day time by means of thermit welding into continuous lengths of several rails, then transported with the aid of a large gang of men equipped with rail tongs close to the edge of the track, and installed during the early inactive hours of the morning. In one case a pair of rail lengths each consisted of seven rails, making continuous lengths of 420 feet as shown in an illustration.



Welding rails before laying, and placing them in 420-foot lengths after traffic has ceased for the day

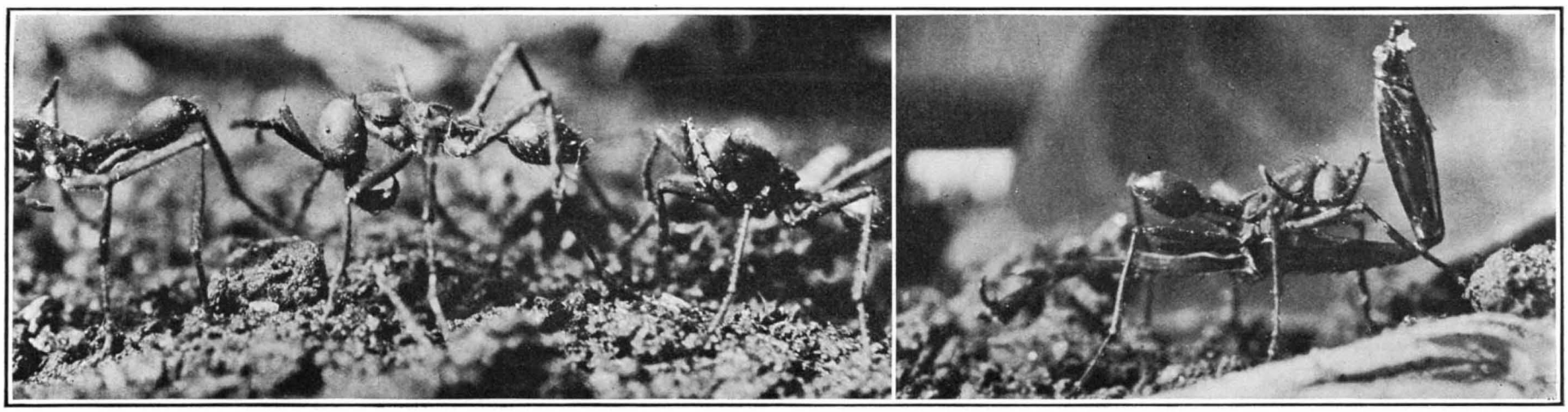
Aluminum Scenery

WOOD has become very expensive in Germany so that at the Chemnitz Opera House aluminum has been substituted for wood for the frames for scenery. Scenery thus mounted is much easier to handle and the fire risk is minimized. The scenery can be attached to both sides, and even decorations can be painted on the wooden frames. No acoustic difficulties have been experienced.

Weathering Tests of Stone

WEATHERING tests, consisting of freezing and thawing of the specimens until disintegration occurs, are in progress at the Bureau of Standards on 22 samples of limestone and 23 of sandstone. Some of the best limestones have withstood 800 freezings without showing any appreciable amount of decay, while the poorer grades of this material were disintegrated by 100 freezings. Tests on the sandstones have only recently been started, and so far the samples have shown no great amount of decay.

A number of limestone and sandstone specimens are also being tested by soaking in a 15 per cent solution of sodium chloride and drying afterwards to obtain a crystallization of the salt in the pores of the stone. This produces an action similar to that of frost but more severe. It has been found that limestones which stood up under several hundred of the freezings were disintegrated by less than 100 crystallizations in the salt test. However, the actual disintegration seems to be similar to that produced by the action of frost, and hence it is believed that there is a possibility of using this method as an accelerated weathering test.



Left: Army ants marching in single file; note the great killing mandibles on the central figure (magnified five times). *Right:* Army ant bringing home as booty the leg of an insect victim. This straddling of the burden is characteristic

Scenes from the Guiana jungle, when the ants are marching

The Army Ants of British Guiana

Jungle Insects that Have Learned the Importance of Force of Numbers and Discipline

By Paul Griswold Howes

Assistant Curator of the Bruce Memorial Museum, Greenwich, Conn.

UPON the ever moist floor of the great dim jungle that covers nearly all of British Guiana, live the gypsy tribes of army ants. These tribes consist of astounding numbers of individuals, divided into various sizes, and upon whom fall various burdens in the general economy of the groups. They make no permanent nests at all, but instead, roam the forests, carrying the entire where-with-all of their social existence about with them.

The first army that the author ever witnessed on the move, was traveling rapidly across an open space in front of the camp. The line of march was not over five inches in width, but it extended across the clearing for a hundred and fifty feet in a snaky band, and continued out of sight into the growth of vegetation beyond. This army moved for many hours without halt, or even the slightest let up, and there must have been hundreds and hundreds of thousands of individuals in the line. Their destination was an old foundation on the edge of the clearing, and into this the insects poured all day long. The ants carried everything that belonged to them as they moved. Nurses could be seen by hundreds, bearing the white grub-like larvæ or young ants, while countless others carried eggs and pupæ, or ants about ready to take up their work in the tribe. Soldiers with enormous curved jaws hurried along with the rest, snapping viciously at anything that attempted to interfere with the general progress of the lines. Where an obstacle hindered the march, dozens of the medium sized ants would make a living filler of their bodies, over which the rest would pass in greater ease and comfort. By night the nurse ants and all the rest were safely in the foundation that they had picked for their transient visit. The nurses could be seen forming a dense network of their bodies, among which the eggs and young were being kept safe and warm, while all about their camp, others rushed here and there, scouting and policing the grounds in a general clean-up of the surroundings.

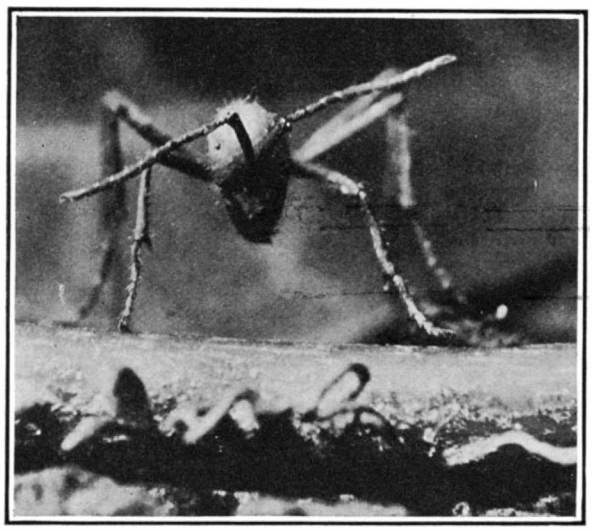
The ants stayed here all night, but by morning they had gone on into the forest. This army was simply moving. The command of instinct had decreed a march only. No hunting was to take place, and so the whole great tribe moved forward in a thin line without a glance from side to side. Such is the marvelous discipline of instinct.

When the command says hunt, everything changes. The milder attitude of the multitude changes instantly. Every ant becomes a ferocious demon, a fiery, reckless and merciless creature that will attack anything and give its life if the necessity arises. They launch themselves into the forest in great networks, that gradually enclose certain areas, and every living thing that is weak, as well as many of the stronger ones, fall before the onslaught.

If one is traveling through the forest, a certain sign of presence of a hunting army, is the calling and chirping of a number of different ant-thrushes, and other birds that have banded together into a flock. These birds follow the armies, partly because of the insect life that is stirred into panic, and partly because of the tit-bits of refuse that the army leaves, in the form of legs and other parts that have been torn from the victims.

When such a flock is heard, a few minutes' hunt will reveal the army at its deadly work, while at other times one will know well enough that the lines have been crossed, by the severe and thorough biting of one's legs, followed by a painful stinging that causes one to take to the trail in haste to remove the energetic insects. Once they bite into the skin their jaws become quite tightly locked so that it is often necessary to pull them apart; and the Indians use them for closing wounds, by causing them to bite, after which they sever the heads from the bodies.

During these drives, every insect is frightened from cover and instantly pounced upon by as many individuals as happen to be near. They actually tear the victim limb from limb and it is then taken to the nest for that day, in many fragments. Almost as soon as an ant has secured a portion of food, it ceases its wild



Front view, greatly enlarged, of a warrior ant, showing the powerful nippers

blood-thirsty actions and goes to the rear, its duty accomplished.

If a large insect such as a grasshopper or a big jungle roach is thrown among the ants, it will eventually be vanquished by sheer weight of numbers. As it lands among the warriors, one or two will lock their jaws upon its legs with lightning rapidity. The sufferer will now hop or fly in agony, but the instant it lands again, several more ants will grab its appendages. This procedure soon weights the victim to the ground permanently, where it is torn to shreds without delay.

Ants returning to the rear often assist one another in various ways. As it is usually the custom to straddle one's booty on the homeward journey, the ant is frequently greatly hampered by the size of the cut. Again a long caterpillar may be the victim, one that has been left intact, owing to its slight resistance, and thus becomes a great burden. In these, and similar cases, ants were observed to come to the assistance of their sisters. They would help drag the meat along or hold the abdomen of a sister up out of the way, and in one case two ants were seen to straddle a caterpillar and thus carry it along on their tall legs, like so many laborers carrying a railroad rail or a big log.

Birds and animals are not immune to the attacking ants, especially young ones. In fact any animal would soon succumb to their myriad bites if there were no avenue for escape. One realizes how great are their numbers when a distinct and strange rustling murmur reaches the ear, due to the thrashing about of countless bodies.

Some creatures have learned to escape. Thus the smaller species of spiders, leap from their perches at the approach of the ants and remain safely suspended upon a silken thread until the danger is past. On the other hand very large snakes are sometimes killed and devoured, before they can get beyond the lines of the army.

The entire tribe does not take part in the drive for food. A large number of workers remain at the temporary nest to care for the eggs and young while the warriors are away, and swarms of workers also cluster the entrance so that it looks like a brown furry vegetable growth, from a short distance. As the burdened hunters return, they are carefully brushed and combed by the workers, and their booty is dropped and carried into the nest by these individuals also. The actual passage to the interior is lined thickly with a network of ants so that every individual must pass along a living passage to gain entrance.

The Indians of Guiana like those of many other South American countries and also the Boviander and white people, have learned to respect the army ants because of their house cleaning propensities. Every house, from the rude thatched benab of the Indian to the solid wooden ones of civilization, are more or less infested with very large roaches, and other insects, and also huge tarantulas, which come only to obtain the roaches. None of these things are liked by the average human being, but the army ants are fond of all of them. They come not infrequently, in tremendous armies, to the abodes of man, and in the course of a few hours leave them cleaner than they have ever been before.

In these great tribes there is but a single Queen. Her sole duty is egg-laying after the colony is once started and she is given the most exquisite care all during her life. She is sheltered and watched and attended like a real Queen and no harm can easily come to her. Periodically, a brood of young Queens and males are hatched. These individuals are winged and as soon as they are mature, all of them leave the tribe in what is called the marriage flight. Each Queen finds a mate. They pair and the males soon die afterward, but each young Queen founds her own new tribe and after bringing up the first workers herself, this little crowd set about to rear about themselves another great gypsy band of army ants.

An effective barrier to keep cattle off the tracks is provided by this uneven assembly of rollers

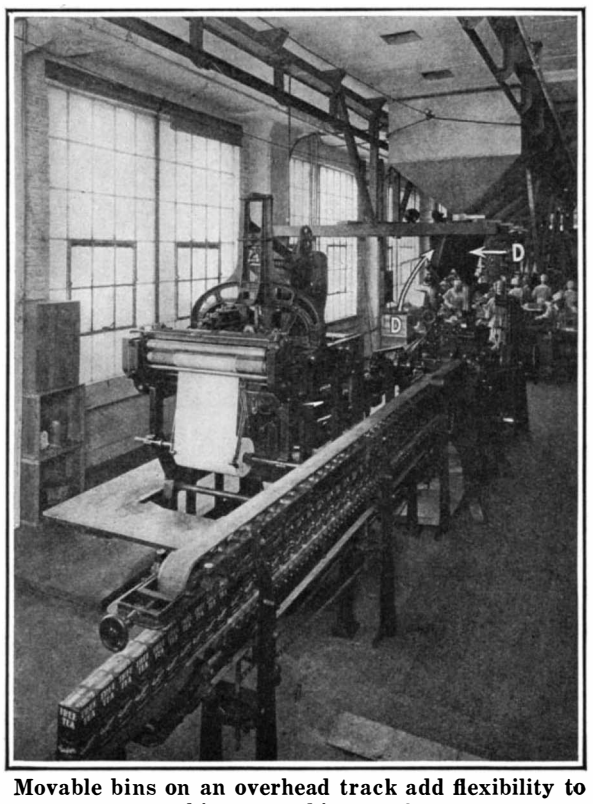
Scaring the Cattle Off the Tracks

MUCH interest is attached to the recent development of a conical-roller cattle guard that it is believed will prove effective in preventing stock from passing. There are four sections, one of which is placed outside each rail and two between the two rails. Each section is composed of conical wooden rollers three inches in diameter at one end, four inches in diameter at the other and twenty-four inches long. Four steel side and end pieces bolted together constitute the frame, by means of which the guard is spiked to the tie. The rollers are supported on metal rods on which they rotate.

As animals approach the guard they are alarmed by the irregular and strange appearance presented by the alternating conical rollers and many do not come any nearer. But if they become bolder and advance up to the guard so as to place one foot upon it, the rollers revolve underneath their feet, and most animals will immediately leave. Where the animal puts one foot upon the rollers and, still unalarmed, tries to advance with another foot, his weight rotates the rollers under his foot and he will find it impossible to proceed.

A Clever Job of Continuous Packing

AN interesting apparatus for the mechanical packing of tea is to be seen in a San Francisco factory. An overhead track system supports a unit of six traveling bins, which can be shifted so as to bring any bin directly above the chute, *D*, that leads to the weighing scales. In this way any number of cans can be packed with any desired type of tea, and a shift made as often as the orders of the day require; or special blends can be made with a minimum of trouble. The overhead system is operated by a drum-wound cable, and any bin can be brought into the dumping position in a few seconds. The bins themselves are kept supplied with tea from larger storage on the floor above, to which they are open. There are six bins, and only five brands of tea to be packed; so that at all times a bin is "left over," and can be filled from above while one of the other bins is losing the last of its contents to the packing machine. In this way tea can be kept running continuously, with never a failure of the supply of any brand and never an empty bin. We have seen numerous applications of the idea of continuous packing, but none that seemed more generally effective than this one.



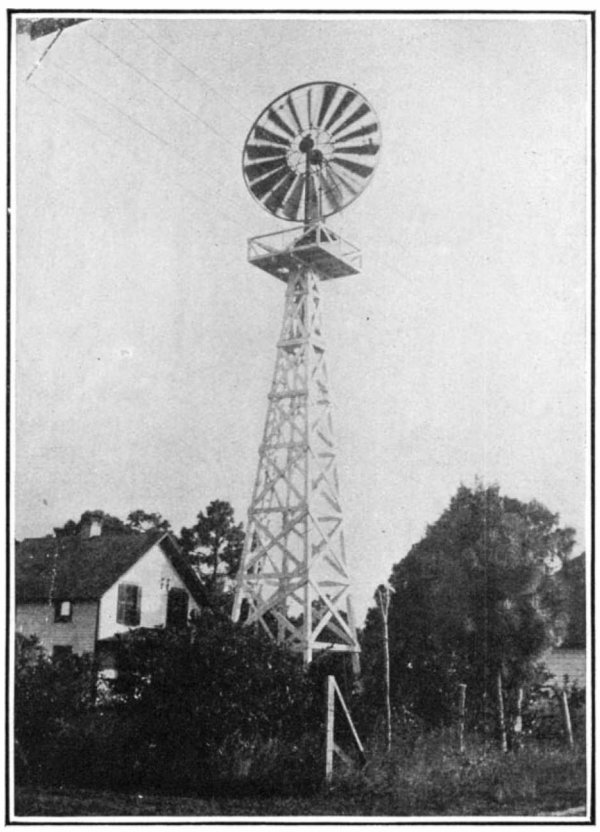
Movable bins on an overhead track add flexibility to this tea-packing outfit

The Wind-Power Automobile

AN automobile whose operating expense includes no provision for power might seem as though it should go in the class with the mysterious green fluid that makes gasoline out of water—it certainly sounds like a crazy dream or an outright fraud. Nevertheless, Mr. A. I. Root, the dean of the American bee industry and publisher of *Gleanings in Bee Culture*, has such an automobile at his winter home in Florida.

The answer is a pair of busy windmills. The car is an electric. The mills are two in number, 16-foot wheels on 60-foot towers. Instead of having a countershaft or a set of gears to multiply the speed of the wheel to the necessary dynamo speed, the dynamo is mounted on the platform immediately beneath the wheel and connected by means of a belt running clear around the circumference of the wheel and then directly to the generator shaft. To provide for varying weather conditions an idler is used to take up the slack of the belt. The belt itself is made of a specially designed fabric which meets with complete success all the weather conditions to which it is exposed. Whether it would fill the bill in a more rigorous climate is not stated; but the mill is manufactured in North Dakota and widely used there for farm lighting, which suggests that blizzards are a mere incident in its life. The generator is mounted on a revolving platform and goes with the wheel as the wind shifts. The cost of a single mill, with switchboard and all other apparatus but without a battery, was given, at the time of writing, as $1500. We think it probable that today it would be somewhat less, but whether the reduction would be a material one we cannot say with any degree of certainty.

It is a familiar experience with users of the gasoline automobile that it is not an economical means of providing small units of transportation. Many cars are employed for little more than the daily drive to the station and back, a run of at the most five to six miles. Cars that develop 20 or even 25 miles per gallon on longer runs are barely warmed up to their work at the end of the run to the station, and give this sort of service at excessive fuel cost. The electric is an ideal vehicle for work of this character, if the work of charging can be done without paying an excessive profit to someone. For charging from a windmill, as light a machine as possible should be secured, with a small battery that does not make much if any more than 25 miles on one charge. A light battery, charged little and often and kept full, is the thing for this usage. The automobile is to be left in the garage and connected with the dynamo all the time when it is not actually on the road. A cutout, similar to the one between battery and generator on the ordinary gasoline cars, must be provided in order to insure that at low speeds or when there is no wind at all the battery shall not discharge through the dynamo. This cutout is operated magnetically, and breaks the circuit leading to the battery whenever the dynamo is not turning over at a predetermined rate. Contrary to what the non-electrician might expect, such cut-outs are neither complicated, nor likely to get out of order.

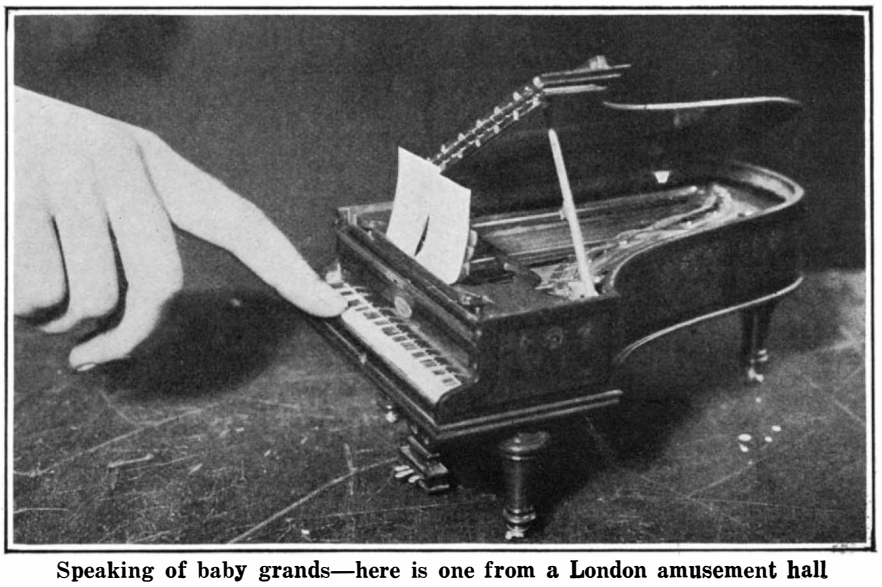


This windmill and another like it drive the family car about six miles per day, and light the house in addition

Mr. Root, from his two windmills, keeps his car fully charged for its regular duty of five or six miles per day, and in addition lights his house. He finds that a single windmill operates rather fitfully, but that with two going at once, even when they stand close together, the wind is sufficiently capricious to insure that one will usually be running at charging speed even if the other is not. Aviators will confirm the inference that considerable variations in air movement are met between points only a couple of hundred feet apart. With his two mills connected up, Mr. Root finds that the charging curve is entirely smooth enough for all purposes.

A Lilliputian Piano

AMONG the attractions of one of London's amusement places is the miniature grand piano illustrated. Exact dimensions are not given us, but the finger of the user affords a very good approximate scale by which the actual size of this tiny musical instrument may be estimated. In spite of its Tom Thumb appearance, this piano can be played in the usual way by one with sufficient control of his fingers. The extent to which the editorial digits find the wrong key on the editorial typewriter make us wonder what kind of a finger this would be; but that does not alter the fact that the piano can be played, just like any other piano, by anyone able to play it. Perhaps, as in the case of some of the string instruments, one picks at this keyboard with an artificial finger-end.



Speaking of baby grands—here is one from a London amusement hall

What Happens When the Tire Hits the Road

Studying the Impacts from Pot-Holes and Obstructions, with Different Types of Tires

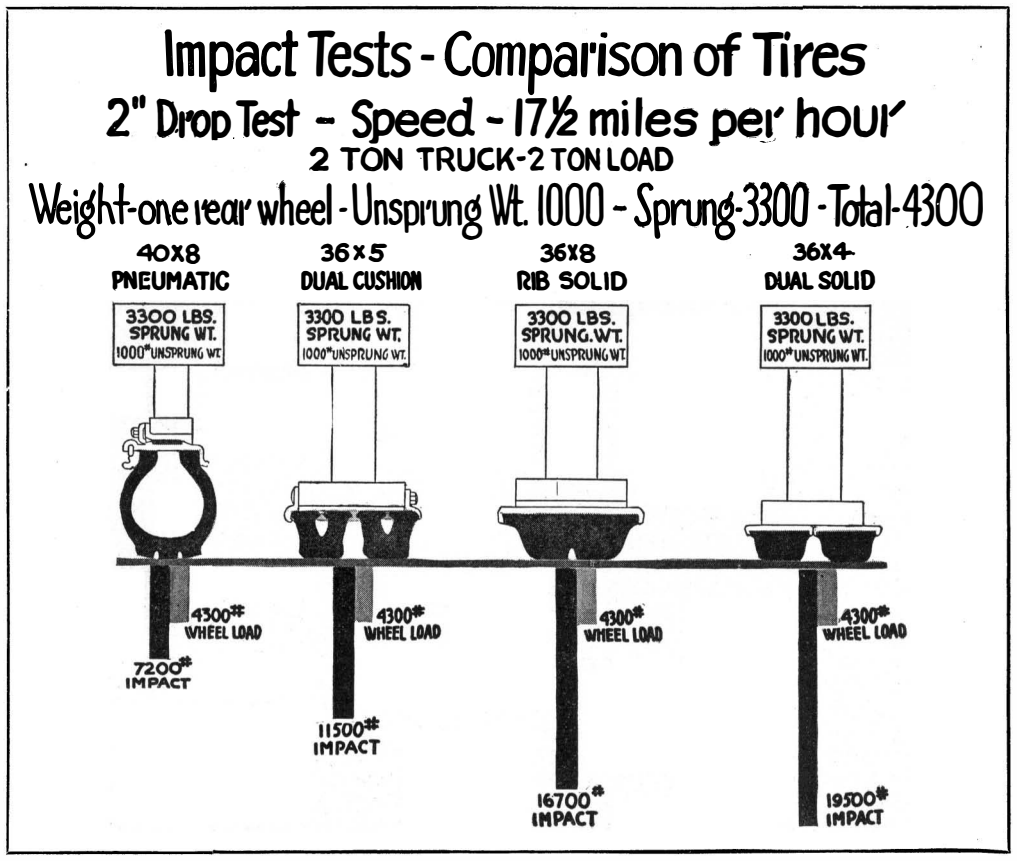
WHO IS destroying America's highways? The road engineer, the truck driver, Jack Frost, the politician, the speed demon and the road builder have all been accused. Each pleads not guilty and the roads go right on disintegrating. Now the United States Bureau of Roads is attacking the question, with every prospect of getting an answer. The investigation deals with road surface, road structure, sub-surface drainage, and traffic. Of permanent value are the findings under the first three heads; but of paramount interest at the moment are the results of the examination into the traffic, and what it does to the road.

Most significant of the findings is that it is not chiefly the dead weight of motor trucks that destroys the highway. If a truck strikes an obstruction on the road, or if it runs into and out of a pot-hole, the wheel comes down on the road with a thud. It is this impact that does destruction, crushing the surface and breaking the foundation.

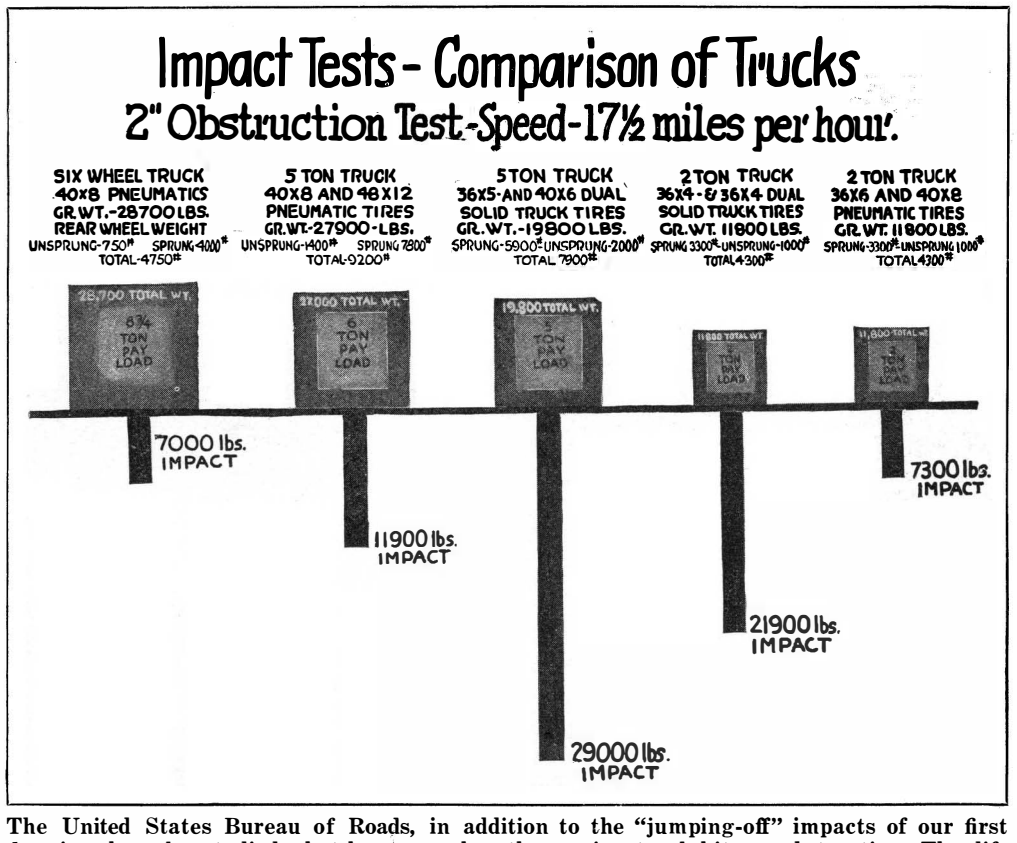
This impact can be measured, as a function of truck weight, of truck speed, of load per unit of wheel bearing-surface, of poor design, etc. Tons of chassis and freight smashing along the highway strike hammer blows upon the roadway; this is not to be avoided. But the force of these blows can be lessened. The chart herewith shows some of the results of the study of the problem. A solid-tired, five-ton truck, operating at 17½ miles per hour with a five-ton load, on striking a two-inch obstacle delivers a blow on the pavement of 29,000 pounds. The same truck, with pneumatic tires, may carry an extra ton of load and under the same circumstances deliver a blow of only 11,900 pounds.

Does this indicate that all trucks ought to be shod with air? By no means. Impact varies with the speed and the load carried. Take the coal dealer, delivering in a business district. The extreme weight of the truck and the load restrict the speed to very moderate figures, and the heavy traffic has the same effect. Comparatively little cushioning is necessary to protect the road and the truck from the jars of impact at these low speeds; so a solid or cushion tire, with its greater bearing surface, is advisable to distribute the dead weight of the load over more of the pavement. As the load goes down and the speed goes up, the demand for cushioning gains in importance and that for distribution loses. Then we may replace one or both pairs of solid tires by the cushion type, combine the cushion with the pneumatic, or, finally, mount four pneumatics. But on all trucks up to a limit of 2½ to 3½ tons, where a wide range of operations is an important factor, the big, fast, easy-riding pneumatics are highly desirable.

There is a right and proper and economic tire for each set of conditions. Knowing the condition—the road, the load, the service to be rendered by the truck—one may follow the diagrams of the Federal engineers and diagnose with a high degree of accuracy the truck owner's needs. Particularly suggestive is the finding with reference to the impact from a six-wheel truck. Obviously, with six wheels, the load per wheel is less and the impact per wheel less; but one would not necessarily be prepared for such a difference as the chart shows. To the layman, in this connection, it may be necessary to point out that six impacts of 7000 pounds each, even if they all come in the same place, will not do the damage that will accrue from four blows, of 11,000 pounds or a bit less each. Conceivably, the road might stand up indefinitely under the lighter blows, and disintegrate rapidly under the heavier ones. Hence a lightening of the blows, by greater cushioning, or by multiplication of wheels, or by any other means, works out into a saving of road-repair costs quite disproportionate to the cost of the better trucking practice.



The blow delivered to the road when a two-ton truck, with a two-ton load, runs into a two-inch hole or rut, depends very largely upon the type of tire carried. At lower speeds the difference would be less, at higher speeds more, in favor of the more shock-absorbing tires



The United States Bureau of Roads, in addition to the "jumping-off" impacts of our first drawing, has also studied what happens when the moving truck hits an obstruction. The difference here is even greater in favor of the more efficient tires than it was in the drop test

Comparing the three types of tire, it seems easily susceptible of proof that the pneumatic has greater cushioning, can be operated over an open stretch of road in a shorter time, and does less damage to road and vehicle, than either of the others. There is a point where the possibilities of time saving, and the need for cushioning, become so small that it is no longer economical to use the pneumatic tire. Slow-moving freight will probably continue to be carried on other types of tire. But the practice of short-sighted truck-owners, of economizing on tires at the public expense as measured in road destruction, cannot go on indefinitely. The graphs of the Federal engineers give ample basis of proved fact for taking any necessary steps to insure that trucks be properly shod for the loads that they carry and the speeds that they attain.

The Senses of Insects

IN the last report of the Smithsonian Institution (1922) Dr. N. E. McIndoo has an interesting article on the senses of insects. After discussing the nature of insect vision, both by simple and by compound eyes, the author proceeds to the sense of smell, and considers it first as a means of recognition. This sense is far more developed in insects than in man, yet Dr. McIndoo found that by smell alone he could distinguish the three castes of bees as well as other components of the hive. It is probable that each individual bee has its peculiar odor, but it is the combination of all these that makes up the hive odor and this is regarded as the most important and as indeed the ruling power in a colony. It is a means of protecting the social life of the bees from without, and the queen odor which is a part of it insures continuation of the social life within. The workers "know" their hive-mates by the odor they carry. This insures harmony and a united defense against attack. The queen odor constantly informs the workers that their queen is present. Even though she does not rule, her presence means everything to the bees in perpetuating the colony. Thus, by obeying the stimuli of the hive odor and queen odor, and being guided by instinct, a colony of bees could not want a better ruler. Among ants the same broad principles hold, but here the family odor is the more important.

What, then, are the organs by which insects recognize these odors? Dr. McIndoo has identified them as small pores scattered or grouped on the body and appendages. A nerve ends in each pore, and the opening is often protected by a hair. By covering the pores, experimental proof of their olfactory function was obtained.

That bees, among other insects, can discriminate between foods is well known, and that their power of discrimination exceeds that of man was experimentally proved by Dr. McIndoo. He ascribes this power, however, not to taste, but to smell. Taste and smell are closely allied, and it is possible that the only difference lies in the organs that respond, the stimuli themselves being identical. In bees there appear to be no such organs connected with the alimentary tract, so that the discrimination is probably made by smell.

Mail dropped in this box in the country is collected in the city, to the great expedition of its handling

A Traveling Post-Box

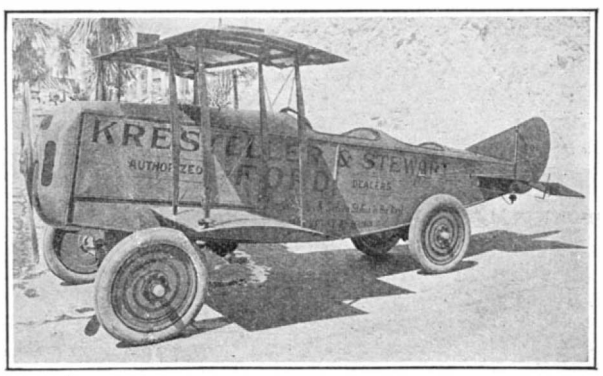
RURAL free delivery is not the only means of extending the scope of Uncle Sam's service to communities and isolated houses off the main line of communication. The latest idea for making the mails more useful involves the mounting, on interurban trolleys, of ordinary mail boxes. At any point along the line letters may be posted in these boxes, to be removed by the postman when the car reaches a good-sized town. This is a long step forward from the condition where the people strung out through the country are dependent upon the once-daily passing of the mail carrier for their contents with the outer world.

Motor Propulsion for the Legless

HIMSELF a cripple through an attack of infantile paralysis, a member of one of New York's oldest families has invented the legless automobile which we illustrate. Though the user is seen with trousers and shoes, his legs are useless to him; and any means of navigation which he employs must be one that can be entirely controlled with the hands. The conventional wheel chair did not appeal to this particular man, and he displayed a touch of inventive genius in designing a motor-driven substitute. It is, in fact, in every detail worthy of the designation "automobile," save only that its dimensions are a bit nearer those of the motor-cycle; it is but 32 inches wide and 70 long. It also strikes nearer the cycle than the car in that it has a single front wheel, steered by bar rather than by wheel. The other controls are for the larger part assembled upon the handles of the bars, where they are easily accessible.

Airplane, or Plain Flivver?

WHILE M. Barbot and his aerial flivver are in the public eye seems a good time to put on display another kind of airplane flivver—one actually built upon the foundation of a Tin Lizzie chassis. As the picture makes clear, this plane is designed for advertising purposes and not for flying, and it does all its running with four wheels on terra firma. Nevertheless, its body is built on exactly the lines of a regulation airplane, even being equipped with rudder and elevators. The rudder gets a practical touch by serving as a direction indicator to the driver behind, and for this end it is connected by cables with the steering gear. The car is equipped with port and starboard lights, and the propeller can even be driven around by the engine.



This airplane-style body is the latest model in fancy flivvers

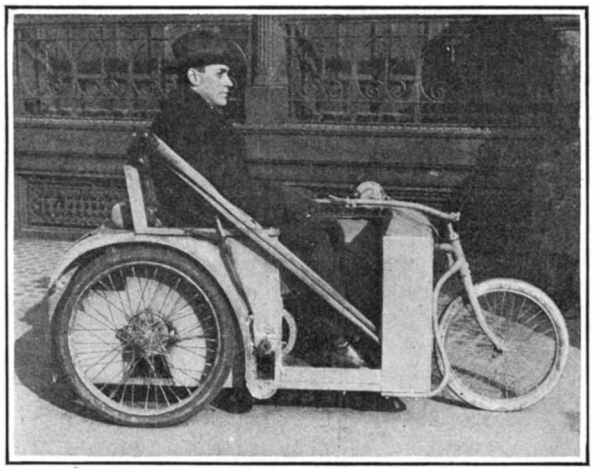
Gas and Oil on the Fly

ONE of the things that plague the long-distance record-seeker, on road or on track, is the stop for supplies. When a tire replacement is in order, there seems no way out; but a recent performance on the Indianapolis Speedway demonstrates that stops for gas and oil are simply a matter of habit. The distance for the run was determined in advance, being set at 3155 miles—the distance from New York to Los Angeles via the William Penn-National Old Trails route. All service aside from the tire replacements was achieved from a second car, which took the track and kept pace with the racing machine at a speed of 50 miles per hour. Inasmuch as the car under test finished the distance in 21 minutes over an even 50 hours, at an average speed of almost 63 miles per hour, it will be seen that the 50-mile filling speed represented a distinct slowing down on the part of its driver. Our photograph shows the process of filling gas into the tank of the racer, with the mechanician attending the business end of the hose.

The Heating Value of Gas

TECHNOLOGIC Paper No. 222 of the Bureau of Standards, for sale by the Superintendent of Documents, Government Printing Office, Washington, D. C., at 25 cents a copy, gives the results of laboratory tests conducted at the request of the Public Service Commission of Maryland on the relative usefulness of gases of different heating values and the correct adjustment of burners for changes in the heating value and specific gravity of the gas.

There was a time when gas was used almost exclusively for lighting purposes, and in the ordinances regulating gas companies, it was usual to require gas having a certain illuminating value. More recently gas



Motor travel for the legless, in a machine that is controlled entirely by hand

has been used more and more for heating purposes and less and less for lighting, or when used for purposes of illumination, it is almost always burned in a mantle burner. This was accompanied by a change in most regulations from an illumination to a heating value basis. Still more recently it has been found necessary in some cases to reduce the heating power of the gas, due to increased cost and other difficulties of manufacture.

The present paper deals with a condition thus brought about, the tests having been conducted primarily to determine whether the consumers in Baltimore were getting as good gas service with the present standard of 500 B.t.u. per cubic foot as they obtained with gas of a higher heating value in former days. The tests showed that with proper adjustment of the appliances the service should be equally good. The relative cost of the service, however, under the two conditions was not taken into consideration in this report.

Wave-Length Measurements in Arc Spectra

COMPOUNDS of the rare earth elements which are used extensively in the manufacture of gas light mantles and cored carbons for electric arcs, and less extensively in the textile and glass industries for their coloring properties, are about the most difficult salts for the chemist to prepare in a pure state. The chemistry laboratory of the University of Illinois has succeeded in preparing some of the members of the rare earth family in a high degree of purity and has submitted to the Bureau of Standards samples of these materials for spectroscopic analysis. The work on the original consignment of materials is now completed and Scientific Paper No. 466 has just been issued describing the results that have been obtained for the two elements gadolinium and dysprosium. Two preceding

Filling a racing car with gas and oil at fifty miles per hour

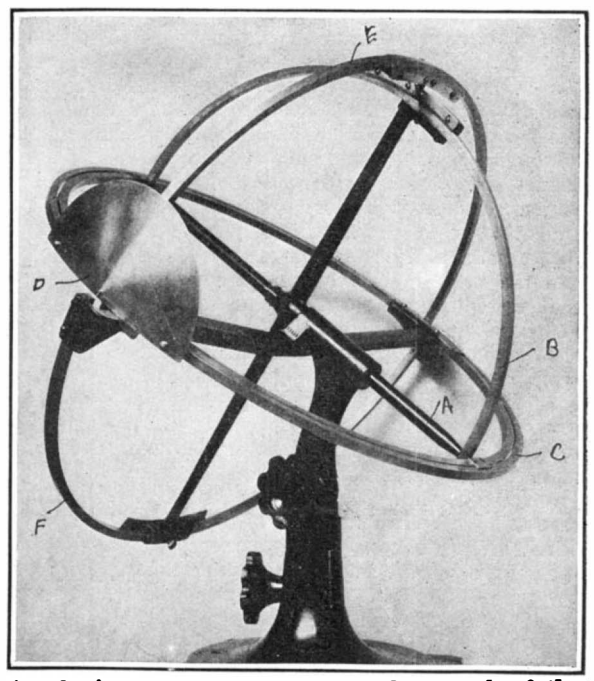
papers have dealt with yttrium, lanthanum, and cerium, and with neodymium and samarium. The spectroscopic analysis confirms the degree of purity attained by the chemists in separating the gadolinium and dysprosium salts from the original materials and in addition yields an accurate description of the green, yellow, red, and infra-red spectral regions of these elements which have only been covered incompletely heretofore.

The data collected from the observations are compiled in two tables, one of which contains about 950 wave lengths in the arc spectrum of gadolinium, and the other, about 800 wave lengths in the arc spectrum of dysprosium. These data are of value chiefly to chemists who are interested in problems of analysis, to astronomers who are concerned with the chemical composition of the stars, and to physicists in connection with atomic structure. This paper can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 5 cents a copy.

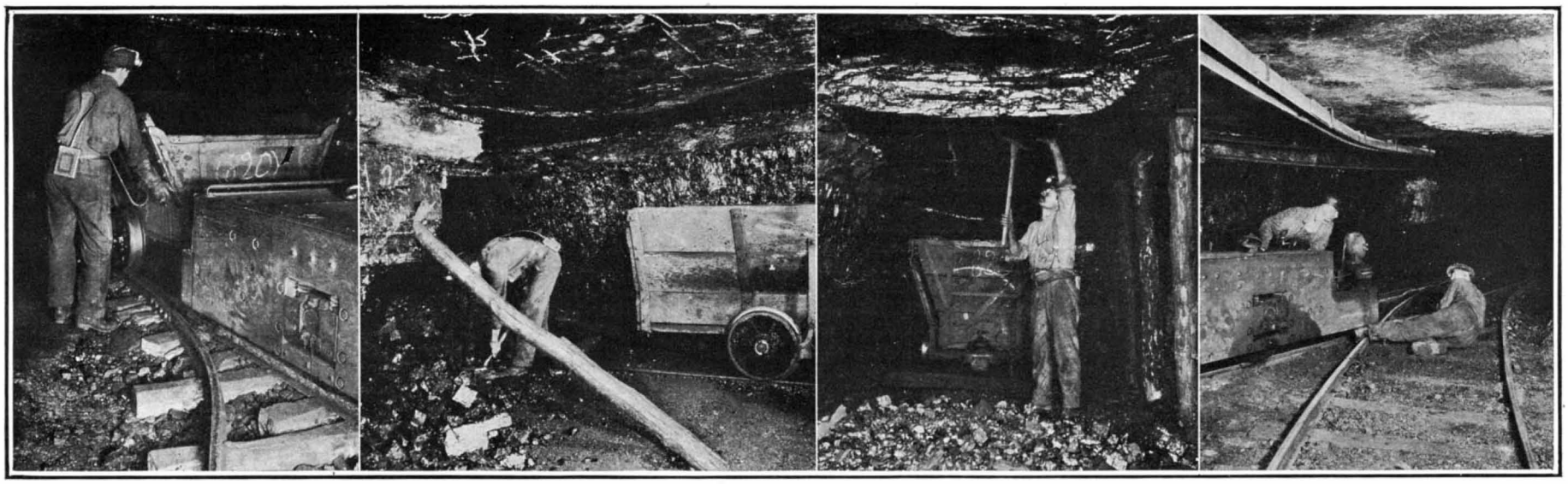
A Novel Instrument for Navigators

USING the spherical-angle calculator illustrated herewith, it is claimed that the data necessary for proper utilization of the gyro compass are obtainable with a greatly increased facility, and a vessel's position determined from a single observation. What this instrument really does is to set up, in the form of a small model, the various astronomical and geographical circles, with the position of the ship with reference to them; whereupon zenith distance and azimuth are read off the zenith circle and the dial, and the ship's position is known almost without calculation. The really difficult part of the customary calculations is the part replaced by the automatic reading of the instrument.

In the photograph, *A* represents the earth's axis. It is journalled to the declination circle *B*, and securely fastened to the latitude circle *C*. At *D*, the center of the compass rose, we have the ship's position—which is of course unknown to begin with, and which gets determined only as the setting of the movable parts of the calculator, to match the observations made, determines it. The semi-circle *E* is the zenith-distance circle, and incidentally represents also the ship's meridian. The correspondence between the model, and the visible universe with the ship in its center, is obvious.



A spherical-angle calculator that does much of the navigator's hard work for him



This man is careful; wears jacket inside overalls; wears tight gloves; carries electric cap lamp

This careful miner has blocked the car with a piece of timber. He does not trust to the brakes alone to hold the car in place

Miner testing roof as he approaches a fall in his room. He detects loose material by its vibration

Snapper, running ahead to switch, catches his foot in open frog. A wooden block in frog would prevent this

Some incidents in the life of the coal miner which make for safety or danger

Safeguarding the Miner

Safety-First Cooperation of the Bureau of Mines, the Operators and the Miners

WHEN several mining disasters, such as those which followed the last miners' strike, occur, we must be careful not to draw the conclusion that mining accidents are on the increase, or that no precautions are being taken to prevent them. As a matter of fact, although the great mining disasters powerfully excite public apprehension, there has been an encouraging reduction in the number of major disasters and deaths in coal mines since 1911. In that year 15 coal-mine accidents occurred with a loss of 413 lives, whereas in 1920 eight similar accidents resulted in only 61 deaths; and whereas in 1911 major disasters caused 15.5 per cent of the total killed at coal mines, in 1920 only 2.7 per cent of the total deaths from all causes were due to major disasters. Now the credit for this improvement is due to the preventive work done by the United States Bureau of Mines. We are told by its Acting Director, Mr. H. Foster Bain, that 12 years ago there was no general country-wide service for the systematic training of miners in matters relating to safety; a slight beginning only having been made in a few scattered points. There was no such urgent need for training in those days; for so long as the mines were small and the workers intelligent and well trained in routine mining methods, and when the pressure for output had not yet speeded up the industry to its present pitch, it sufficed very well for each man to look after himself and for the bosses and superintendents to rely upon improvised methods when major accidents occurred.

But when the enormous expansion of coal mining brought about the introduction of new and little trained labor, and when the scale of production was so greatly increased, there was a rapid rise in the dangers of mining. The increased output in the mining of today has been obtained from the substantially same number of miners as ten years ago; but the personnel is not nearly so well trained in mining. There was a series of disasters and mine explosions immediately prior to the organization of the Bureau of Mines and the problem before the Bureau was that of reducing the number and severity of these. To this end the Bureau of Mines sought the cooperation of the State Mine Inspectors, the mine operators, and various other agencies; and while the full benefits resulting from preventive and remedial measures cannot be gaged accurately by figures only, the statistics, as given above, show that greatly beneficial results have been obtained.

When the work of obtaining records of the injured at the mines was undertaken by the Bureau in 1911, many of the States kept no record of such accidents; and the record shows a small number of injuries reported to the Bureau during the first few years after 1911. The apparent increase in injury reports, which was noticeable from 1911 to 1916, was due in a large measure to State requirements for reporting such injuries and to the rapid enactment of compensation loss by many States during that period. Today mine operators in practically all States must report non-fatal injuries. The Government now obtains accurate statistics both of deaths and injuries. They show that the number killed per thousand persons has decreased from 4.86 in 1911 to 3.66 in 1920. Of late the injury rate has ranged from 234 to 242 per thousand men employed.

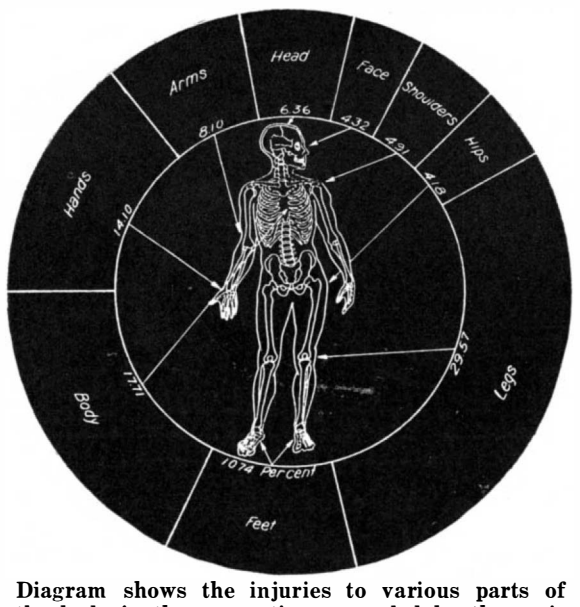
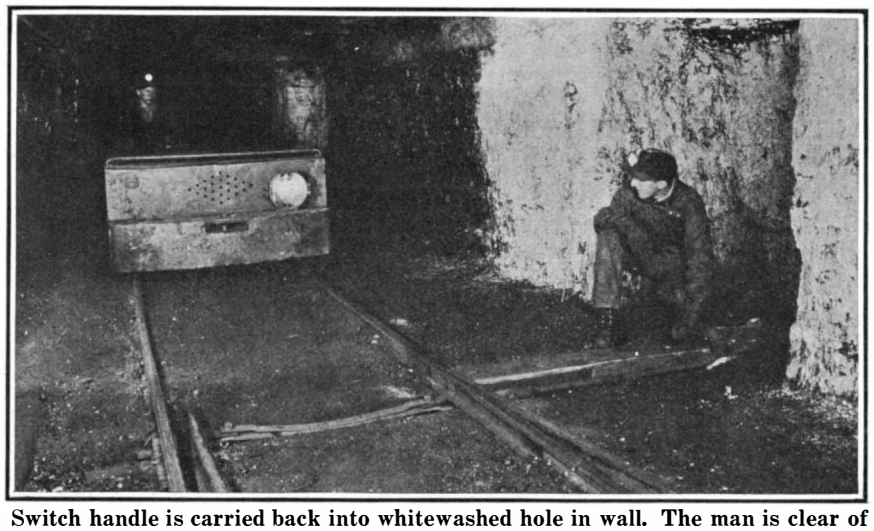


Diagram shows the injuries to various parts of the body in the proportions revealed by the accident statistics

A very effective agency in reducing the number of accidents and mitigating their effects upon the injured, is the character and extent of the training which is given to those engaged in mining. Miners who receive certificates of first-aid training are instructed and examined in the anatomy of the human body, the treatment of hemorrhage, fractures, burns and shock, and the transport of wounded persons. Certificates of rescue training are given those who pass a physical examination, who wear breathing apparatus while doing hard labor in atmosphere containing noxious and irrespirable gases, and demonstrate their ability to adjust and take care of such apparatus and to perform the duties of rescue men. The course of training represents a total of 15 hours of intensive work. During the decade ending June 13, 1920, the Bureau of Mines trained 50,971 persons in rescue and first-aid methods. In 1911 the 734 persons trained represented less than one miner in every thousand; but in 1920 the number trained was 8993 which represented nearly ten miners in every thousand employed.

As regards the causes of coal-mine fatalities, it should be noted that nearly half of all deaths at coal mines results from falls of roof and coal, and most of this class of accidents take place at or near the "working face," which is the place where the miners actually mine the coal. A few occur elsewhere in the mines, as on slopes and haulage ways. Many of the falls at the "face" are due to failure of the miners to take down loose rock or coal or to set props under dangerous places in the roof.

Mine cars and locomotives underground are responsible for about 17 per cent of all fatalities, the victims usually being run over or caught between the cars and side of haulage way.



Switch handle is carried back into whitewashed hole in wall. The man is clear of the haulage way and in a safe position

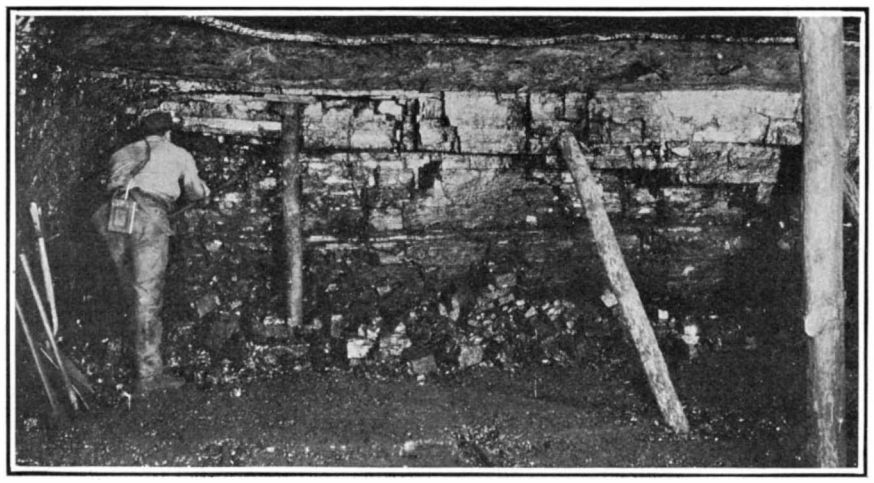
It will surprise the public to learn that mine explosions, although generally given much prominence in the daily newspapers, have caused only a little more than one-tenth of all fatalities during the past decade; and, excepting 1922, the percentage in recent years has been considerably below that mark. Most of the gas explosions have been caused by the carrying of open lights into accumulations of gas, while the explosions of coal dust have frequently resulted from windy or blown-out shots or to what, in the absence of dust, would have been local explosions of gas.

Accidents due to powder and other explosives have caused six per cent of all fatal mine accidents; between three and four per cent have been due to electricity, and less than five per cent to miscellaneous causes underground.

Of all fatal accidents at coal mines, about 90 per cent have occurred under-

ground, between two and three per cent in shafts and slopes, and slightly less than eight per cent above ground.

A most important part of the safety-first campaign of the Bureau consists in the publication, from time to time, of circulars illustrated by photographs, which show the miner, and the operator also, what he should do and what he should avoid in the prevention of accident and the safeguarding of life and limb. The excellence of this method is revealed in the half dozen photographs, which we have chosen from a circular issued in 1919 entitled "Dangerous and Safe Practices in Bituminous Coal Mines." These have been chosen from 200 similar photographs which make up the bulk of the circular. Each has beneath it a few explanatory words, and even without these the pictures themselves should convey a clear lesson to that large proportion of the miners of today who cannot read English and are, therefore, particularly liable to injury.



This miner has set a prop under the loose lip before starting work with his pick

The pictures here represented are selected from those which teach the miners the principles of self-protection, through care and forethought, and of these there are some 180 in the pamphlet referred to. In addition to these there are about a score of pictures which illustrate good practice in the equipment and oversight of the mines, such as the provision of miscellaneous safety devices, among which may be mentioned an underground machine shop, sub-foremen's offices which are kept locked, but with telephone, first-aid box, stretcher and skeleton map of mine so placed that they can be reached from the outside; locked explosive magazines; accident bulletin boards, on which an accident which occurs is recorded for a warning to the miners; safety mottoes placed conspicuously at the roof of the mine, and many similar devices.

Enough has been said to show that this governmental work is highly humanitarian; that it has already, in a single decade, gone far toward making mining a reasonably safe occupation, thus robbing this absolutely essential industry of the terror with which it has too long been associated in the public minds.

A Diminutive Electric Tractor

HERE we have two views of a diminutive and ingenious tractor which for work performed in proportion to its size is certainly remarkable. It was built in Germany in response to the urgent demand for the exercise of all possible economy, particularly in the matter of transportation of materials for short distances in large industrial plants. Special effort is being made to replace manual labor by mechanical drives of one kind or another, and it is considered that these conditions are well met by this little machine, which is called in Germany an "electric horsetractor."

The complete tractor as shown in the larger engraving consists of a steel frame carried on two wheels provided with solid rubber tires. The accumulator battery is in two parts, one carried before and the other behind the axle. Above the axle is mounted a little 3.6 horsepower motor, which drives it by means of gears, a chain, and a worm drive. The speed is low, being only 3.28 feet per second. The operator walks between the shafts, on one of which is mounted a controller, and he steers the tractor and keeps it on a level keel so to speak. For security, two small rollers are attached, one in front and one behind the tractor with a small clearance above the ground. The advantages of this little vehicle are found in its small dimensions, its low weight, and the ease with which it is handled. Also it has proved to be very economical, operating at low expense. The ordinary capacity of the battery is 32-kilowatt hours for three hours of discharge; but a single charge is sufficient for two days' intermittent operation under the average conditions of work. The average tractive effort is about a quarter of a ton with a maximum effort of one ton. It can haul up to one hundred tons where the load is running on the level upon steel rails; on average undulating highways it can haul about ten tons, and, running on the banks of a canal, can haul 400 tons of load in boats or barges. The tractor is 3.15 feet wide, 2.92 feet high and the length over all from the front hook to the end of the shaft is 12.78 feet. The total weight is about two tons.

Industrial Use of Powdered Coal

POWDERED coal has been successfully applied, and is commonly used in open-hearth furnaces; bushelling and puddling furnaces; continuous-heating furnaces for blooms and billets; furnaces for heating, reheating, and forging, annealing furnaces for malleable iron and steel castings and plates; sheet and pair and annealing furnaces and tin pots; galvanizing pots; soaking pits; ore roasting and volatilizing; copper-ore roasting and smelting; the zinc industry; the gold and silver industry; calcining kilns; lime burning; refractory materials; and also in the fertilizer industry. It is used more than any other fuel in the cement industry and has been successfully applied for steam raising. Whenever powdered coal has displaced hand firing the coal consumption has been reduced considerably.

By the term powdered coal is meant coal subdivided so that it may be burned in suspension when mixed with the necessary supply of air and may be conveyed easily by means of a screw conveyor, by compressed air, or suspended in a stream of low-pressure air to the furnace.

The principal advantages over hand and stoker firing lie in the comparative ease of conveying coal to furnaces and in the practically complete combustion of the coal, with little excess air, in close contact with the material to be heated, thus avoiding the convection, radiation and excess-air losses which accompany hand or stoker-fired furnaces placed outside reverberatory and many other furnaces. For this reason the most successful field of use for pulverized coal installations has been for those purposes where they have replaced externally-fired furnaces. For purposes such as steam raising, where the burning coal can give up heat directly by radiation to the boiler heating-surface, there is therefore less opportunity for reducing the fuel consumption by burning powdered coal instead of burning coal on a grate, since the losses which may be reduced by substituting powdered-coal firing for hand firing or stoker firing are those only which are due to incomplete combustion and using excess air. These losses, however, are not inconsiderable.

Certain drawbacks to the use of powdered coal are cited by the author of the bulletin. Before powdered-coal firing can compete successfully with grate firing it is obvious that the gain due to the smaller consumption of powdered coal must offset the cost of preparing, conveying and burning it.

There is a further disadvantage with powdered coal. In grate firing the ash is left on the grates and in the ash pit. But with powdered coal the ash is blown into the furnace, out through the stack, and with some badly designed furnaces out through openings in the furnaces. It may also form a troublesome slag, and fill up the flues so as to impede the draft.

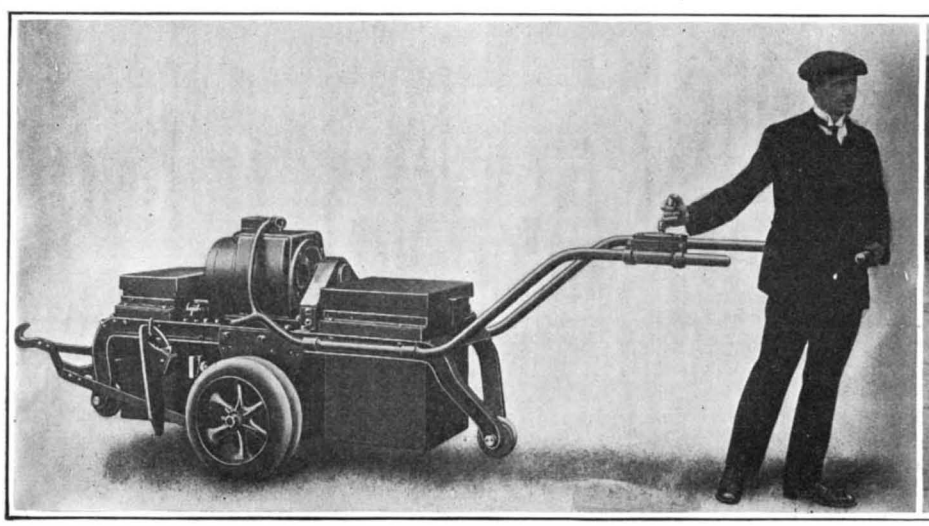
On the whole, powdered-coal plants cannot be said to be clean. There are fairly clean powdered-coal plants; but generally, though not universally, a plant using powdered coal is dirtier than a grate-fired plant.

Powdered coal is better adapted for firing stationary water-tube boilers than other boilers. With these boilers furnaces of sufficient size and of the correct shape may be constructed, and the gases pass through no tubes wherein ash may settle to obstruct the draft and shield the heating surface. It has been found difficult to burn powdered coal in locomotive and cylindrical marine boilers because the combustion space is too small to permit the coal to be burned completely.

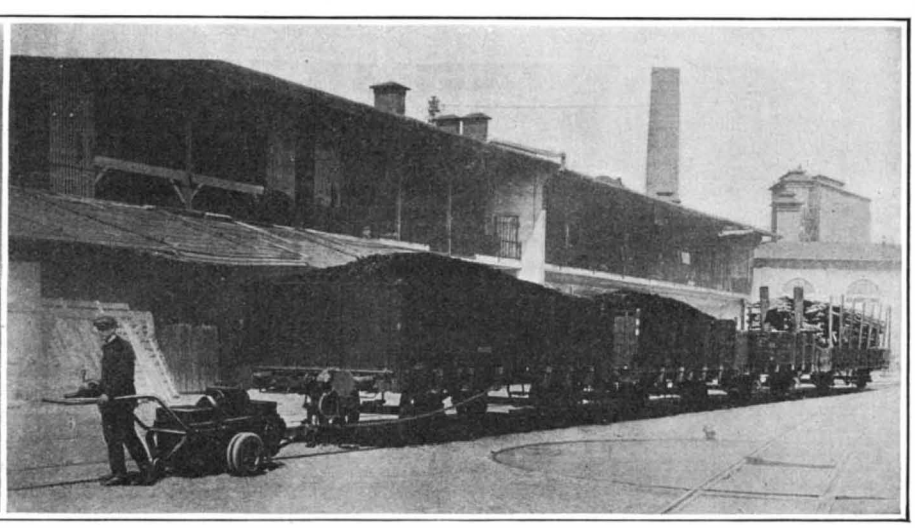
Although men have been killed by explosions and fires in powdered coal plants, the causes of such accidents are known and precautions may be taken that they may not recur. Greater precautions are required with some systems than with others. For instance, dangerous fires and explosions have occurred more frequently with the direct low-pressure air system of transport than with the indirect screw-conveying or compressed-air transport systems, although the indirect transport system has not been entirely free from disasters. The possibility of a dangerous fire or explosion in a well-designed, well-managed powdered-coal plant is remote and should not influence the prospective user of powdered coal against installing it.

Mincing Microbes

A MACHINE for killing microbes by the simple method of cutting them into bits is described in the *British Medical Journal*, which states that by this means inoculations against infectious diseases may be made with germs from which the poisons have been removed. Thus if detoxicated vaccines are used very much larger doses may be administered with increased chance of protection from the disease. Although microbes are so small that 5,000,000 of them in a mass are invisible and a billion are only the size of the head of a pin, this electrically driven machine will cut or smash them. The microbes are suspended in a liquid and forced against 70 small knives at a speed of 60 miles per hour so that 28,000,000 cuts are made in one minute. As the germs remain in the machine 20 minutes, they receive 560,000,000 cuts.



A two-ton pony tractor



Tractor hauls loaded cars on the rails

The Maple Sugar Industry

The Tree that Made Vermont Famous, and How its Delectable Juice is Harvested

By C. O. Ormsbee

MAPLE syrup is a product of the sap of the maple tree, concentrated by evaporation to a boiling point of 219 degrees. At this temperature one gallon of maple syrup weighs 11 pounds, and, including very small percentages of various other solids, chiefly of mineral origin, contains 65 per cent of sugar and 35 per cent of water. Maple sugar is a product of the same sap, so concentrated, that, upon cooling, it will crystalize and form a solid mass. Maple molasses is a form of glucose resulting from the disintegration or reversion of maple sugar, when concentrated to a low degree. Maple cakes, maple cream, maple powder and various other pure maple products, consist of maple sugar, variously manipulated, and at various temperatures. And maple blends are syrups produced by the melting of maple sugar, cane sugar, together with water in various proportions.

Maple sap is obtained by wounding the maple tree. This operation is termed tapping, and while there have been various forms, the method which is now in universal practice is to bore a hole, not exceeding half an inch in diameter, to a depth of from two to three inches, at a convenient height, and in a sound, healthy portion of the trunk of the tree. A metal, tubular spout, so constructed as not to interfere with the flow of the sap, is driven tightly into the tap-hole, and a bucket made for the purpose and usually of tin is suspended immediately below the spout. The sap, being forced from the tree by internal pressure, trickles through the spout and falls in little droplets into the bucket below. The buckets usually have a capacity of from 12 to 16 quarts, and it is rarely the case that a sufficient quantity of sap flows to more than fill a bucket during the 24 hours which intervene between the times of gathering. Many maple sugar makers make a practice of tapping the larger trees in two or more places, claiming that a greater amount of sap is thus obtained.

Botanists recognize something like 100 species of the maple tree as inhabiting various parts of the globe. And it is a common characteristic of all of them to yield this sugar-bearing sap if wounded during the dormant period and under certain atmospheric conditions. But, of these, there is but one species that will yield the sap in sufficient quantity and purity and of a sufficiently high sugar content, and that is closely enough associated in large numbers to allow the profitable manufacture of maple sugar. This is the sugar maple, the hard or rock maple of the lumberman, the *Acer saccharum* of the botanist. This tree is found only in North America, and its range extends throughout the entire valley of the St. Lawrence River and its tributaries, where it is the predominating tree, and westerly as far as Minnesota. From Maine it extends southwesterly, well into the Carolinas, thence westerly through Kentucky and Tennessee, well into Arkansas and Missouri, in which states it spreads, in fan shape, over an extensive territory.

The Bureau of Forestry is authority for the statement that there are, scattered over this entire area, approximately 100,000,000 maple trees. A study of the returns of the last census reveals the fact that of this number but 18,000,000 are utilized in the manufacture of maple sugar, and that, even including the sugar equivalent of that part of the product that is marketed in the form of maple syrup, the entire output of maple sugar of the United States falls under 50,000,000 pounds annually. Of this amount 87 per cent is produced in the five states of New York, Vermont, Ohio, Pennsylvania and Michigan. The total output of Canada is around 30,000,000 pounds annually. It is known that but one-third of the available trees in Canada are utilized, while the numbers of non-utilized trees in the unsettled regions runs high into the millions.

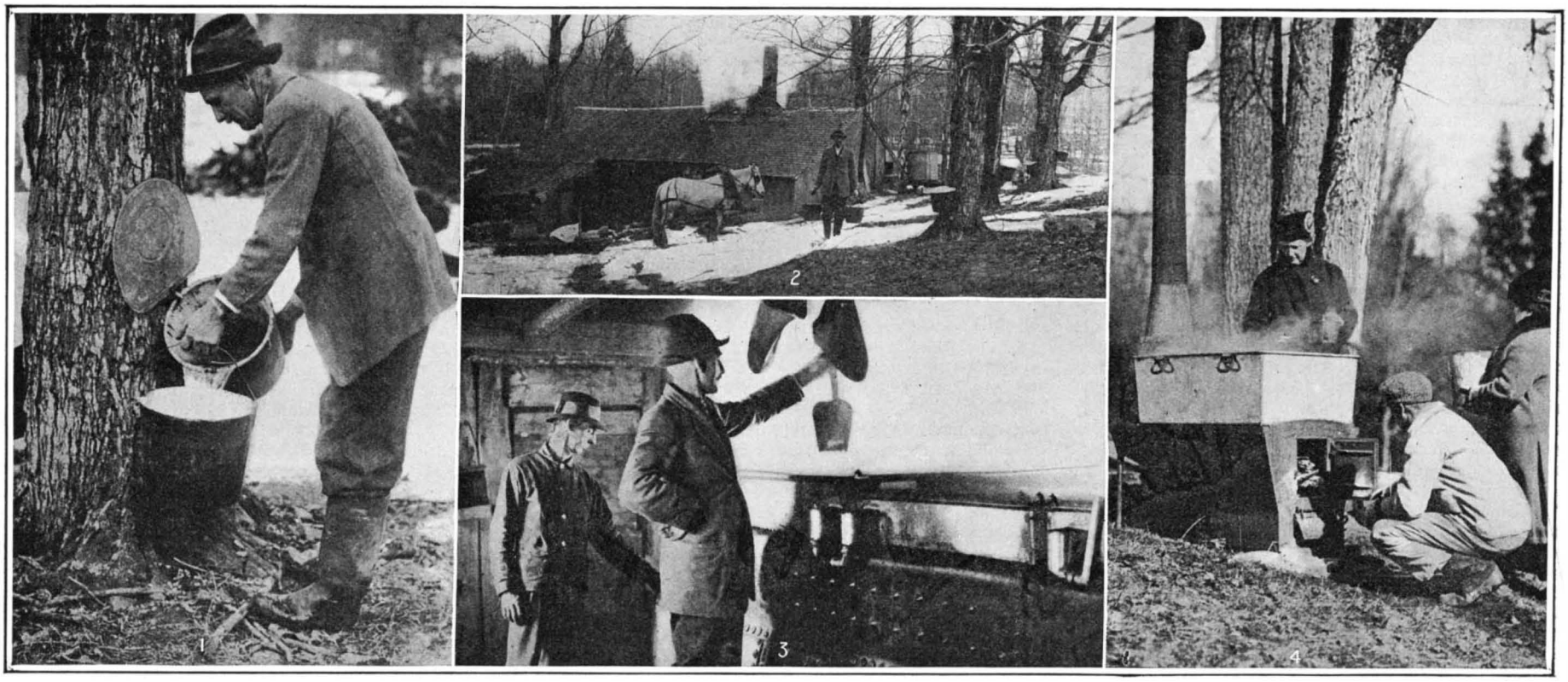
But the maple tree will yield its sap only during its dormant period, and even then only under atmospheric conditions which include bright, clear days during which the temperature rises well up into the seventies, followed by equally clear nights with a drop in the temperature to several degrees below the freezing point. And because in the north these conditions prevail in the highest degree during the month of April, is the chief reason why this is preeminently the sugar-making month in the north. In the south, however, such conditions prevail to a less extent of variation, but over a much greater length of time; and the sugar season covers several months, with light daily yields, but with an aggregate considerably greater than the average yield in the north. The average yield per tree throughout the United States, as shown by the census, is a trifle under three pounds. Yet trees vary greatly in this respect, and a maximum yield of 42 pounds from a single tree has been reported. And the sap from different trees varies in sugar content, from a minimum of scarcely a trace to a maximum of 10 per cent, with an average of close around 3 per cent.

Briefly stated, the theory of the sap flow is essentially as follows: Moisture is abstracted from the soil by means of very minute appendages, termed "root-hairs," and located near the extremities of the smaller rootlets. This moisture consists of an extremely weak solution of the various mineral elements, chiefly in the form of nitrates, which enter into the composition of the tree and form the ashes when the substance of the tree is burned. It is transferred from the root-hairs into the rootlets, thence into the larger roots, and finally into the trunk of the tree, in which it is carried up into the branches and into and through the leaves. During its passage it loses, by evaporation, an immense percentage of moisture, which passes off in the form of a watery vapor; and another immense percentage is broken up into its elements of hydrogen and oxygen. Air is also forced simultaneously through the leaves; and during its passage it parts with the carbon dioxide that was intermingled with it, and emerges as pure air, while the carbon dioxide unites with the hydrogen, thus forming starch. The oxygen thus set free emerges in the form of ozone; the insoluble starch is transformed into soluble sugar, as occasion requires, and forced back into the sap, which henceforth is known as "elaborated" sap, and which forms the food of the tree. In this form so much as is needed for immediate growth is carried to points where new tissue is being made, and the remainder is stored for future use. Then after the fall of the leaves, and influenced by atmospheric conditions already described, this stored sap begins to work its passage toward the exterior of the tree and into the space between the bark and the wood, and in some not well-understood manner a gas, probably nitrogen, is generated, which creates the pressure previously mentioned.

Maple sugar is identical in its composition with cane and beet sugar, and were it refined to a state of absolute purity it would be indistinguishable from them and would possess no more value. But commercially it is never so refined. It owes its superior value to the presence of an elusive essence, of a most deliciously delicate flavor, and which chemists have as yet been unable to isolate. And, contrary to the opinion that is prevalent in many localities, high-grade maple sugar is of a very light, almost white color, and maple syrup is almost transparent in its clearness, with an indescribably smooth and delicious flavor. The dark-colored, opaque syrup so often exposed for sale is a low-grade product, made so by the incorporation of caramel and bacterial products developed by careless and unsanitary methods of concentration.

For maple sap, as it comes from the tree, is as clear

(*Continued on page 214*)



1. Emptying a tree-bucket of its sap. 2. Gathering pails of sap from the tapped trees. 3. Inside the sugar house, showing the great cast-iron boiler or evaporator. 4. An outdoor sap boiler

Glimpses of New England's outdoor cold-weather industry—maple sugar production

Whole Wheat Bread Without Flour

MAN for ages has made bread by several methods—and none of them has been right. The most recent contribution consists in the methods which may be grouped under the term "the modern milling industry." The aims of this industry have been more commercial than hygienic.

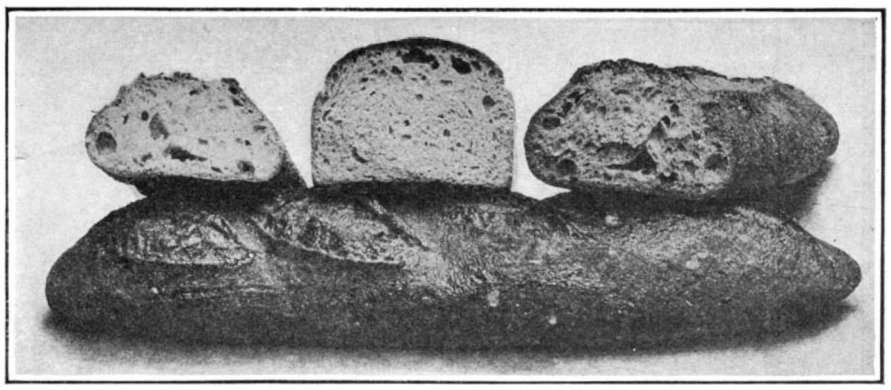
An examination through the microscope of a grain of wheat will reveal that there is a white central portion, protected by two envelopes. Between these envelopes is a brown substance. Outside them is the bran, which is not a food substance. The modern flour mill has been operated with the sole aim of producing a white flour, and with this in view only the central part of the grain is retained, the cylinder machinery eliminating the two envelopes and the material between them. But the sad fact is, that in this space between the envelope lies the major part of the nutritive value of the berry, and all its vitamines. All this is discarded in the effort to get a white flour and a white bread.

The test of the vitamine content of food is a simple matter. It has long been known that pigeons, mice, rats and guinea pigs, fed solely on ordinary white bread and water, die from lack of essential elements of the diet. At the same time it is known that the prevalence of rickets and bone diseases among under-nourished humans is to be ascribed to the absence of vitamines from the ration. Because of this lack in the ordinary white bread, one could gorge himself on this food and slowly starve to death.

For many years specialists have been trying to retain all the nutritive elements of the wheat berry, while keeping the bread white and soft. Kneiff made white bread in this way, but it was not soft—it required supernormal teeth for its mastication, in fact. A later scheme, known as the Mege-Mouris method, failed because of the elaborate process of fermentation of the grain which it employed. A new system now put forward in France, however, gives great promise of providing the solution. It eliminates all slow sifting to free the grain of the bran; and in three distinct operations of washing, maceration and sifting, which can be carried on simultaneously, in a machine whose cost is so low as to be within the reach of all, it has developed a practical way of conserving the gluten and the vitamines of the wheat.

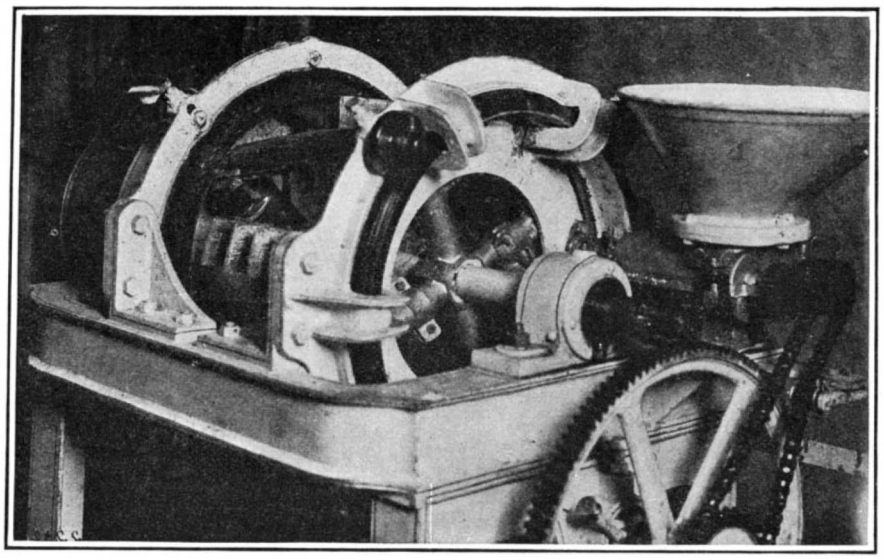
The washing not only cleans the grain, but makes it easier to crush the bran and peel it off from the kernel that contains the nutritive elements. After the washing, the clean wheat is macerated to bring it to the necessary degree of hydration. Sifting then replaces the ordinary milling process, separating the bran from the pulp and leaving with the latter the highly nutritive portion between the outer envelopes.

The most startling feature of the new process is that its product is not flour, but actually dough. It contemplates the elimination of flour from the domestic economy, and of the flour mill from the industrial establishment. It contemplates that the housewife buy the whole wheat berry, just as it now goes from the thresher to the mill; that she pour these kernels into her machine, and receive out of it the dough for her bread. All the nutritive values of the wheat are retained, and the useless and indigestible chaff is discarded at the same time. The machine is no larger than the ordinary family washing machine, and like so many other household utilities it can be operated with the current from the usual electric light socket.



French and English loaves made by the new process, retaining all the vitamines

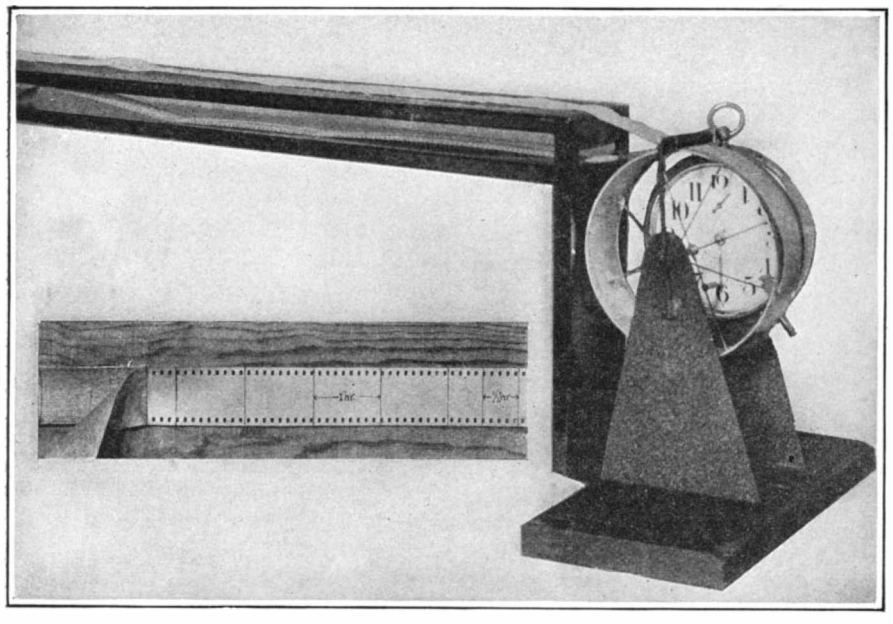
The main part of the machine consists of a large perforated drum into which the wheat is poured through a funnel. The grain goes through a continuous crushing process inside this drum, accomplished by means of rotating cylinders operated by a four-horsepower motor which produces from 25 to 30 kilograms of dough per hour. While the dough is thus being prepared in the machine, the bran is separated out and falls into a receptacle in the bottom of the drum, while the dough issues simultaneously from another opening. The dough is ready for the usual leavening process, and in half an hour may be put in the oven. The bread thus obtained has an agreeable taste; it is not pure white, for it contains the inside cover of the wheat kernel. It seems probable, however, that the housewife of today is educated beyond the point where a snow-white color stands in her eyes as the hall-mark of purity and quality.



Internal view of the machine that makes dough from the whole wheat berry. The cylindrical drum is removed to show the rotary crushers

While the experimental work has been done entirely on the home-sized model, the new method does not necessarily demand that the housewife make her own bread. The machine will presumably be obtainable in large sizes, suitable for bakeries of every magnitude from the small village establishment up to the factory that makes bread for a city. This factory will derive the same advantage in making bread direct from wheat, and in making bread with all the wheat in it, that the individual housewife would enjoy.

The two figures in the new development are Messrs. Pointe and Navarre, two well-known French scientists and engineers.



The drying-time meter, with inset showing a piece of marked film removed from the apparatus after a test of the drying-time of varnish. Note the sharp line at which the tissue ceases to adhere to the film

Measuring the Drying-Time of Varnish

THERE have been disputes among producers and consumers as to the drying-time of paints, enamels, oils, and various varnish products. Many of these have been due to the fact that the method of determining the dryness of a film (touching every hour with the finger) has not been well defined, and especially to the fact that observations could not be made with regularity over the drying period which often occurred late at night. In an attempt to overcome these two factors, Mr. H. A. Gardner of the Paint Manufacturers' Association, has experimented for several months to develop an automatic drying-time meter. Several types were designed and constructed before one that would give satisfactory results was developed.

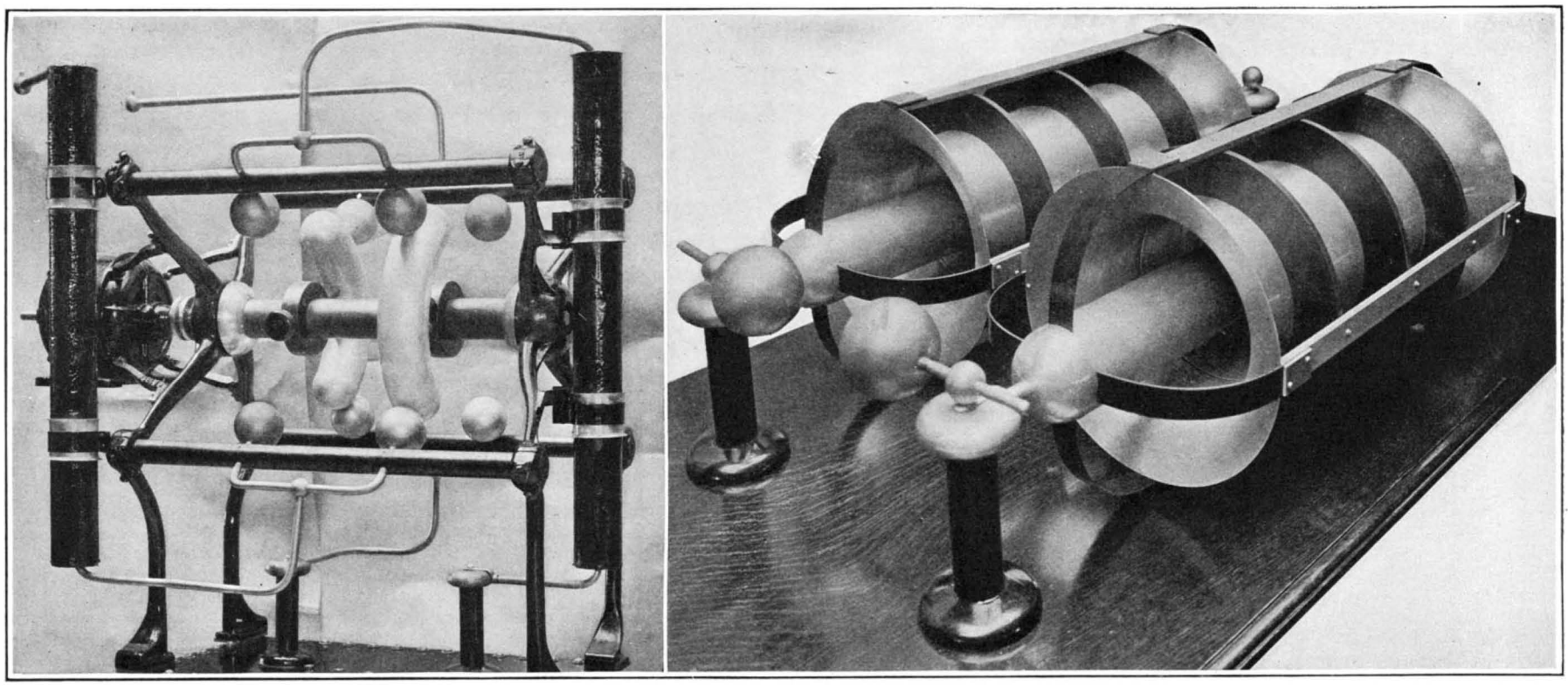
It will be noted in the illustration that the apparatus consists of an alarm clock device fastened on an upright base. Attached to the hour hand of the clock is a very lightly constructed wire wheel covered with a circular drum formed of light tin plate or of aluminum. The drum is slotted to receive the test piece upon which the coating is applied. This winds under the mandrel rod at the top of the drum and is pressed in contact at that juncture with a sheet of soft, light tissue paper of the same width as the test piece. Both of these are automatically pulled from an adjoining double shelf stand, by the action of the clock. Just so long as the coating is wet, it will stain the tissue paper at the point of junction, the paper adhering quite tenaciously to the film. Just at the point of firm setting of the coating, the paper will no longer be stained when it comes in contact with the test piece and will not adhere thereto during its subsequent journey around the drum.

The test piece developed for this work after a trial of many materials, consists of a roll of celluloid moving picture film (waste short ends of undeveloped raw stock) that has been light struck but not developed. This material was selected because of its opacity (white silver coated surface) upon which, applied, clear coatings are quite evident. Because of its great smoothness of surface, paint and varnish coatings do not penetrate it, but dry upon the surface somewhat as they would upon glass. Moreover, the solvents usually present in paint and varnish apparently do not affect the film, and they seem to evaporate in the same time as they would from tin or glass. Solvents of the ester type, or acetone-containing solvents, such as may be used in lacquers, could not be used. Moreover, such film is of a standard size and character of finish and is obtainable in practically any part of the country at a low cost from moving picture firms.

Tarnishing and Detarnishing of Silver

THE Bureau of Standards has recently made an investigation of the tarnishing and detarnishing of silver at the request of the Department of Agriculture. This investigation has shown that the tarnish ordinarily observed on silver is the sulfide film of which certain colors are characteristic and indicative of the extent of the tarnish. The effect of hydrogen sulfide gas by itself on silver is relatively small, but if small amounts of moisture and sulfur dioxide are present the action is greatly accelerated. Tarnishing is also made more rapid by the presence of alkaline films and soap films. Conditions for producing a standard reproducible tarnish were found, and the weight and thickness of the tarnish film were calculated.

In studying the methods for detarnishing silver especial attention was given to the electrolytic methods. Moss silver is produced when the tarnish is reduced electrolytically and the properties of moss silver were therefore studied. Comparisons with other methods were likewise carried out to determine the losses in silver that occur. The relative merits of solutions used for the electrolytic process were compared to determine the rate of cleaning and the possible corrosion of the specimens.



Left: The rectifying switch mounted on the high-tension transformer. *Right:* Close-up view of the air-condensers that make it possible to read the actual high tension potential across the X-ray tube

Two major electrical features of the new precision X-ray apparatus

Precision X-Ray Apparatus

New Means of Rectification and Voltmetering that Take the Guess-Work Out of Roentgenology

ROENTGENOLOGISTS today are taking increased interest in X-ray therapy. X-ray apparatus which has been offered as an instrument in therapy has not attained the high degree of engineering perfection which our knowledge of the subject warrants. The medical practitioner is able to have his dosages measured with ease and accuracy within one part in a thousand; whereas his brother, the Roentgenologist, has been forced to measure his in almost unbelievably crude guesses.

One of the variable factors that has not heretofore made itself amenable to precise treatment has been the constancy of the wave-form in rectification. We have heard much about the long-wave and the short-wave rectifiers; but nothing about the constant form of wave rectifier.

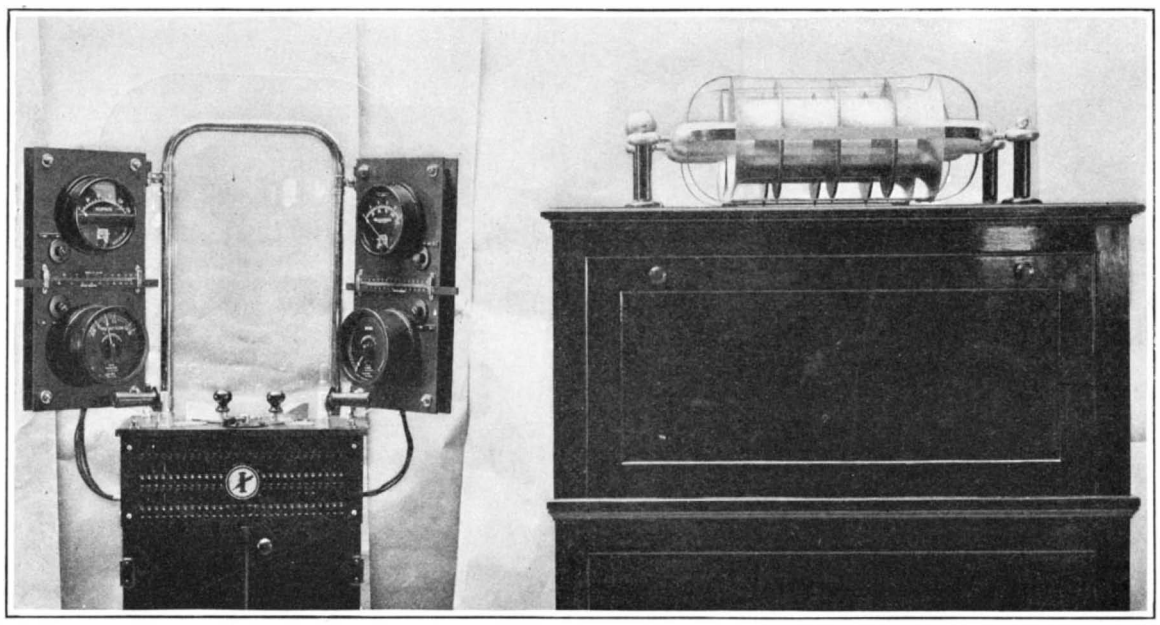
It has been pointed out by adequate authority on numerous occasions that pointed spark-gap variations are not alone unreliable because of electrical conditions, such as oscillations, which occur in the circuit; but that they are also greatly affected by atmospheric humidity and by changes in operation as the points begin to wear away. Because of this, a strong agitation has been set up for the use of sphere gaps as a means of measuring the parallel spark-gap of an X-ray machine, instead of the older pointed gaps. All high-tension mechanical rectifiers heretofore constructed have been essentially revolving pointed spark-gaps. It is, of course, understood that to fit this definition the electrodes do not necessarily have to be actually pointed, but that they just have substantially small surfaces; very small balls, for instance, might be substituted without getting far away from the inherently bad characteristics of true points. To get entirely away from these difficulties the surfaces substituted for the points must be decidedly large. The thought which suggests itself is, then, to design a rectifier which has the characteristics of a sphere gap and not that of a pointed gap. By doing this we may not only eliminate the inconsistencies of the needle-point gaps, but at the same time substantially do away with the corona discharge and with the obnoxious generation of ozone and nitrous acid accompanying it.

The practical result of some such line of reasoning as is embodied in the above paragraph is displayed in our first photograph, which illustrates a rectifier newly designed and now on the market. The spheres are stationary, and the revolving spheres have been replaced by "toroidal segments"—to adopt a rather mathematical term—which they in reality generate during that part of their path that covers somewhat less than a full semicircle. A further advantage, appearing on inspection of the figure, is that rods are used for all connections. With the spheres for the stationary electrodes and the segmental toroids for the revolving ones, then there is no place for corona discharge into the air, and no current is conducted through the shaft.

After we have introduced a rectifier that meets our requirements, the next thing is logically to think of means for accurately measuring the energy developed. The sphere gap cannot be used as a measuring means, with accuracy, where the circuits have large charging currents. Further, the sphere gap when used as a voltmeter requires such skill as to introduce a considerable personal equation. It is not possible to arrest the movement of the spheres immediately on spark-over, and the reading observed depends upon how soon after spark-over they are arrested. Furthermore, a sphere gap cannot be read continuously during treatment, for it requires sparking over, the noise of which may frighten the patient, and, moreover, it necessitates turning off the current to extinguish the arc—which is quite impracticable.

When Fortescue first suggested the sphere gap as a means of measuring voltage, it was necessary to devise a means of calibrating sphere-gap voltmeters. The instrument employed—in fact, devised—for this was a precision air condenser, having its discharge measured by a galvanometer or a milliammeter, the latter being calibrated directly with crest kilovolts. Utilizing this device, we have a direct-reading crest kilovoltmeter which may be read at all times without disturbing the line conditions, and which will be independent of the line-charging current as well as of personal error due to manipulation of the apparatus.

Accordingly the manufacturers of the precision X-ray outfit with which we are engaged have developed this air condenser in a fork suitable for use on the instrument as a voltmeter. A sphere gap is included as a limit gap for the machine, and further as a means for checking one crest measurement against the other if desired. Thus we have finally a constant form of rectifier which may be depended upon, a direct-reading crest voltmeter, and a precision milliammeter which insures the best accuracy possible. The whole apparatus ought by all means to put X-ray practice upon a basis of precision far beyond anything which has yet been approached in this important field.



Left: The control-stand top, emphasizing the complete insulation and the absence of live switches. *Right:* The completely assembled machine; the rectifying switch, shown above, is inside the cabinet

The external aspects of precision X-ray apparatus now at the disposal of the practitioner

Adrenalin, the Drug of the Hour

WITHIN the past few months the daily papers have been publishing news items with reference to the drug adrenalin and its remarkable life-restoring properties. Adrenalin has been hailed as the raiser of the dead. It has been endowed with most mysterious and wonderful properties. In fact, the publicity has been so strong and so widely distributed that people today must think of this "new" drug as a sort of preternatural substance, perhaps something like the famed alchemists' philosopher's stone or elixir of life.

The truth of the matter is first that adrenalin is not the new drug that people generally believe it to be. Its prominence in the day's news is due to the fact that certain physicians have lately experienced considerable success with its use in revivifying the dead, especially in bringing to life babies that were apparently born dead. But the properties of adrenalin have been known for at least 50 years and applied for at least 25.

Adrenalin was first discovered in the suprarenal glands by the French chemist and physiologist Vulpian in 1856. The suprarenal gland is a ductless gland, whose exact function in the human and animal body has only been partly understood within the past few years. It secretes a substance known as adrenalin, epinephrine or suprarenine, which possesses most fascinating properties. It is a great energizer or stimulant, serving to contract the arteries and increase the blood pressure. For example if the brain is informed of some great danger threatening the body, or if it registers great fear, the impulse is transferred by means of the wonderfully swift and sure carrier nerves to the suprarenal glands and they are called upon to discharge their substance into the blood current to energize and stimulate the muscles into powerful action. Anger also results in activation of these glands and this is why the doctors tell us that anger is bad for a person with high blood pressure, for anger serves to accelerate the secretion of adrenalin which has the power of further increasing the blood pressure. This also explains the extraordinary strength of the insane.

Adrenalin was first prepared from the suprarenal glands of animals, such as bullocks and sheep, and the fact that it will increase the blood pressure was first observed in 1894. It was not, however, until 1900 that the distinguished Japanese physician and chemist, who recently died in New York City, Dr. Jokichi Takamine, succeeded in isolating the active principle of the suprarenal glands. This feat made it possible to study the physiological effects of the substance, and its real clinical history starts with Dr. Takamine's preparation of the crystalline substance adrenalin. These crystals are white, and dissolve with difficulty in water. Adrenalin solution has a bitter taste and is slightly alkaline. It is found in three chemical forms, and it is important that it be manufactured in the proper form, as not all have the same physiological activity.

At the present time there are two methods of preparing adrenalin. The drug is extracted from the suprarenal glands of sheep or oxen, or else it is manufactured synthetically from catechol, which is itself a synthetic product used as an antiseptic and in photography. In the extraction process the glands are properly disintegrated with water, containing a little acetic acid or muriatic acid, and an extract is obtained. The extract is concentrated by evaporating off the water. Then alcohol is added to precipitate the impurities, the solution is filtered, evaporated further in a vacuum apparatus and treated with ammonia. In a few hours the adrenalin crystallizes out and may be purified by recrystallization from ammonia. About 125 grams of adrenalin are obtained from 112 kilograms of the fresh tissue. The synthetical process is quite complicated and need not concern us here, but it was due to the interest exhibited in the manufacture of this drug by chemical processes that its uses were investigated further and its application in what is known as "bloodless surgery" was developed.

The most recent use for adrenalin, wherein it is injected into the muscles of the heart, is perhaps the most startling of all the wonderful applications of this marvelous drug. It is claimed that the dead heart, especially in the case of the new-born babe, is so stimulated by the drug that it commences beating again. The heart is a powerful organ, perhaps the strongest muscle in the entire body, for it must work incessantly and must be able to respond at times to the most severe demands. It is built very strongly and it can endure rough surgical usage even beyond what may be expected of it. Nevertheless, it cannot be operated upon as freely as the other organs of the body, for there must not be any suspension of its functions. The use of adrenalin renders important aid not only in heart operations but in operating on adjacent organs. In such cases the heart has been accustomed to be artificially stimulated by the surgeon, who actually grasps it in his hand and squeezes it so as to produce a flow of blood through the body.

Adrenalin is also of great help in operating on the eye, the nose and throat, where it is desirable to avoid excessive flow of blood. An injection of adrenalin serves to drive the blood away from these parts, for it contracts the blood vessels and prevents a profuse flow. It also possesses the properties of an anæsthetic, especially useful in operations on the eye.

Adrenalin is a wonderful drug. There is no question about that, but it must not be supposed that it is a cure-all and save-all for everything. There is no such thing as a universal therapeutic agent. Then again, adrenalin is not a universal "raiser of the dead." It is only in exceptional cases and under very special circumstances that adrenalin has actually caused a dead heart to beat again. The medical scientists are well aware of its properties, and use it in many ways for alleviating diseased conditions of the organs. That some of them, more courageous than the rest, have now and then applied it in extraordinary ways and have produced really remarkable results with it only serves to emphasize that with a drug of this character no one is entirely familiar with all the effects that can be produced. Careful experimentation and trial may reveal still more wonderful uses for this strange substance.

Leather Produced From Degreased Hog and Sheep Skins

THE leather section of the Bureau of Standards has recently completed investigational work on the quality of leather produced from degreased hog and sheep skins. In general, the results show that the degreasing process is very efficient, practically all of the grease being removed without apparent damage to the elements needed for making leather. Leather made from the degreased skins is superior to that made from the natural skins, and the time occupied in tanning is reduced with more effective results. Leather made from degreased hogskins is equal in physical properties to calf leather, while leather made from degreased sheepskins appears to have sufficient firmness and an improved appearance which makes it suitable for upper leather in some types of shoes instead of goat leather.

It is believed that by degreasing sheepskins and hogskins before tanning, leather can be produced which can be brought into general use for shoe uppers and as far as the quality of the leather is concerned, it appears logical for packers to utilize hogskins for leather purposes.

No published report is available on this work at the present time, but one will be issued as soon as possible and the notice of it will appear in the Technical News Bulletin of the Bureau.

The Life History of a Star

WHEN Dr. C. G. Abbott recently stated that, as shown by careful observations and measurements, the heat radiation from the sun to the earth had diminished from 3 to 4 per cent during the past fifteen months, this disclosure may have alarmed some timid pessimists, but it caused no serious general apprehension. Many openly scoffed at the statement and ridiculed it.

Granting that the observations upon which Dr. Abbott's statement was based were thoroughly reliable, how are they to be interpreted? Do they mean that in eight or ten years the sun's radiation will be 50 per cent less than now and we shall have to crowd around the equator to keep from freezing to death? Or, are we to consider this diminution of radiation merely as a passing phenomenon caused by certain disturbances on the sun for which science cannot account?

Scientists, knowing how carefully the observations and measurements of the sun's radiation, which were begun about 20 years ago by the late Prof. Langley and continued by Dr. Abbott, were made, are inclined to accept the figures deduced by Dr. Abbott as correct. But, being aware of the fact that the sun is subject to cyclic disturbances which periodically affect the conditions on the earth, like cycles of sun spots, etc., they do not apprehend a continued and rapid decline in the heat radiation of the sun that would make the earth uninhabitable in a few years.

At the same time, there is no longer any doubt in the minds of our scientists that the sun, following the inexorable laws which govern the evolution of stars from the cosmic elements of nebulæ and their gradual devolution into cold and lifeless stars, has progressed so far already on its devolutionary down-curve that its extinction is merely a question of time. But this need not cause any anxiety at the present time—our sun will probably continue to supply the earth with light and heat for millions of years to come. For what is a million years in the life history of the stars?

According to modern astronomical theories, the history of the origin and evolution of all stars is practically the same. Our sun also is a star, though insignificantly small compared with others and its history, so far as its main features are concerned, is typical for all other stars.

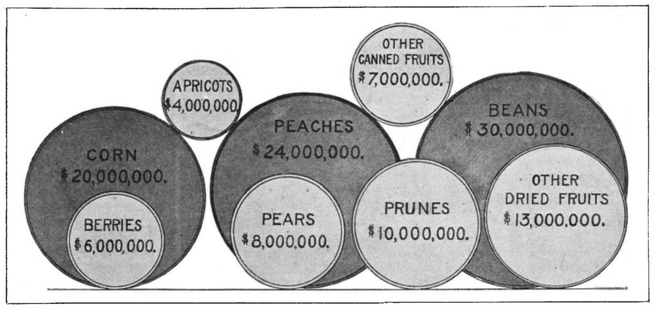
Stars are believed to originate from nebulæ by the condensation of the mass of elemental gases of which the nebulæ consist. Spectral analysis has disclosed the presence of only three gases in the nebulæ examined: hydrogen, helium and nebulium, an element unknown, as yet, on earth. Of all gases known, hydrogen and helium offer the greatest resistance to condensation by liquefaction, and nebulium is probably similar in that respect. It is more than probable that other elements could not be spectroscopically identified in any nebulæ because they could not exist in gaseous form at the temperature of stellar space, closely approaching 273 degrees Centigrade, the absolute zero. No evidence of the existence of the heavier elements in nebulæ has ever been found, but it is not impossible that they may exist in the center of the nebular mass, following the laws of gravity, while only the rarefied light gases surrounding the denser center betray their presence when made luminous by Hertzian waves passing through space. Whether this is really so, or, whether the nebulæ, from which the stars are evolved, are composed in the beginning of the three gases above mentioned only, while the heavier elements are gradually evolved from them by rearrangement of the structure of the atoms under the synthetizing effect of condensation, is still an open question.

The condensation of the nebular mass causes a contraction of its volume and, as a result of the crowding together of the atoms, generates heat. During the early stages of the evolution of the star, the nebular mass, still highly rarefied, yields readily to the contracting influence of condensation. The mass shrinks rapidly, causing a correspondingly rapid increase of temperature. During the steep up-curve which marks the evolution of the star, the volume of its mass shrinks rapidly and its temperature rises from near absolute zero to temperatures estimated, in some cases, at 20,000, perhaps even 30,000 degrees Centigrade. The maximal temperature, which a star attains at the apex of its evolutionary curve, depends on the volume of its mass. The greater the mass, the higher will be the maximal temperature of the star at the apex of the curve. Our sun, which probably did not, even at the apex of its evolution, attain a temperature of more than 12,000 degrees Centigrade, is now far advanced on its curve of decline; it has become a dwarf among stars, with a temperature estimated at 5320 degrees Centigrade. How insignificantly small our sun is, compared with other stars, becomes evident from the fact that, for example, the diameter of Betelgeuse is approximately 230 times, that of Antares more than 400 times, greater than that of the sun.

That our sun is approaching its final extinction is beyond reasonable doubt, for its mass has reached a high degree of condensation, with a mean density equal to one and one-half times that of water or approximately one-fourth the estimated mean density of the earth.

During the early stages of the evolution of a star its temperature rises rapidly until it reaches its maximum at the apex of the rising curve, but there is no corresponding increase in its radiation, as the rise of temperature is almost counterbalanced by the shrinkage of the radiating surface. After the apex is passed the rate of condensation diminishes and with it the temperature of the star. Slowly the volume of the declining star shrinks, its radiation becomes weaker and finally ceases altogether—the star has reached the end of its career, has become a dead star.

How long it will be until our sun reaches that point, it is impossible to foretell with any degree of certainty, but the prospect need not worry us. Its radiations shall probably continue to maintain life on our planet for millions of years to come.



Graphic statement of the value of canned fruit, etc., put up by our commercial canneries during the year 1921

Stretching the Harvest Through the Winter

A Graphical Survey of a Year's Output of America's Canning Industry

ON ITS face, an industry that turns out products bulking as those in our drawings on this page bulk, is worth talking about; on its face, such an industry is interesting and important, and there must be much to say about it that is worth saying and worth discussing. Before we try to say it, though, we must define exactly what this industry is.

It will be observed that we have included in its scope everything in the way of canned fruits, dried fruits and canned vegetables; and that we have excluded canned meats and fish of every description, as well as pickles, sauces, etc. The division of our preserved-foods industries into two general groups along the line suggested by this inclusion and exclusion is obvious enough, and at first blush might seem simple. But the inconvenient fact is, there is much overlapping. Numerous establishments that put out canned fruits put out also pickles and similar articles. Particularly in the matter of canned soups is there a large ambiguity; for soup is a packing-house product, and at the same time a product of the vegetable cannery. Uncle Sam, in his census, splits the soup-makers along exactly this line, including the soups put up by the meat-packers in the product of the packing industry, and those put up by other factories in that of the canning industry. We follow his lead; and this explanation constitutes sufficient definition of just what is included in the industry of fruit and vegetable canning and preserving, which we display graphically on this page.

The goods which figure in our pictorial statement are not all packed in the same way. Some of them come in cases containing 24 cans of 20 ounces each; some, 24 cans of 30 ounces; some, 24 cans of 34 ounces; and some are packed with 48 ten-ounce cans in a case. To reduce all this to a common denominator, we have shown all the products in pounds first, and then in dollars. The pictures answer satisfactorily the questions "How much?" and "Of what value?" which are the first to occur to us in connection with a manufacturing industry.

The various cans, crates, etc., have been faithfully worked out to scale by our artist; every one of them is of the correct size necessary to contain the poundage which it is represented to contain. That our annual consumption of canned fruits and vegetables is of a volume dwarfing the Woolworth Building may surprise us, but it is true.

The humble bean constitutes the largest single item as regards mere quantity, with the raisin—unexpectedly to most of our readers, we imagine—a very respectable second. In point of value the dried grape reverses the order; and when we call it by that name, and reflect upon California's vanished wine industry and the necessity of doing something with her vineyards, we need no longer wonder at its place near the head of the list.

Most interesting is a geographical survey of the canning industry, with the view of noting which States produce the bulk of the various commodities. Of the beans, Indiana cans about five times as much as the second State, referring to the baked specimen; while New York has a long lead in putting up string beans, and New Jersey accounts for more than a third of all the limas that go into cans. Wisconsin leads in beets, with New York a good second, and "no third." In canning corn three States run neck-and-neck, Iowa, Maryland and Illinois all putting up over two million cases; while Maine and Ohio distance the other States with. about a million and a half cases each. The case of corn, by the way, holds 30 pounds. Not unrelated to the canning of corn is that of hominy, in which Indiana has about two-thirds of the total production. Wisconsin is the only State worth mentioning in connection with peas, accounting for more than half of the nine million cases. Indiana leads in canning pumpkins, Maine in squash; California is responsible for 99 per cent of our canned asparagus. Sixty per cent of the canned sweet potatoes are about equally distributed between Maryland, Mississippi and Virginia, with the other States nowhere, individually. California and Maryland do practically all the spinach, and the habit of putting corn and beans in cans together, and calling the result succotash, prevails in New York to such an extent that it takes the next three States combined to equal the output of the Empire commonwealth. Of the tomatoes, California has four times, and Maryland three and one-half times, as big an output as Virginia, the third State.

The canning of apples is more distributed than that of any other commodity, New York leading with less than half a million 51-pound cases, while eight other States have more than a hundred thousand cases each. Oregon and Washington can about half the blackberries and Maine about two-thirds of the blueberries—call them huckleberries at your peril! California does about half of the cherries, Colorado and Michigan more than half of the gooseberries. Oregon and Washington monopolize the loganberries, and Maryland the pineapples. The three Pacific Coast States account between them for practically all the prunes, while the putting up of raspberries is mainly confined to Michigan, New York and Washington. Strawberries are fairly well distributed; four States do, each, more than 10 per cent of the nation's total, and five others have more than 5 per cent; Michigan and Maryland are the leaders. California comes strong in the balance of the list with half of the pears, two-thirds of the plums, seven-eighths of the peaches, and all of the apricots save a vanishing minimum.

Of the dried fruits, California and New York run neck and neck as far as apples are concerned, and the rest of the tale is all California. The land of the Native Son dries all the raisins that are dried in the United States, and does not fall far below this standard in the case of the prune, the peach and the apricot.

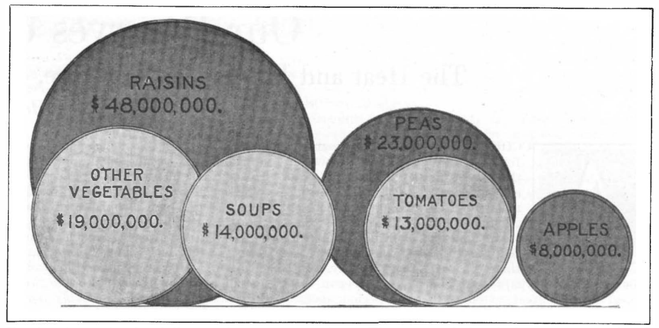
In most instances these figures show that the canning industry depends upon the growers; peaches are canned and raisins dried, corn and beans put up for the winter, in the States where they are grown. The nearest thing to an exception to this principle which the list shows is the prominence of Maryland throughout. This prominence becomes even more pronounced when we line the States up according to the total value of their canned goods. California is the first, without competition, having an annual output of 220 million dollars. New York, with 54 million, has a long lead in second place. Maryland, New Jersey and Pennsylvania are practically tied for third, with 30 millions each. A curious phenomenon is seen when we cast our eyes down near the bottom of the list, and find Virginia, with $5,500,000 worth of product and 498 individual establishments—more than California itself, and more than any other State save New York. Kentucky, with only 28 establishments, has half again as much output. Virginia, apparently, is the home of the one-man cannery. In fact, her 498 establishments averaged for the year but 2123 workers—four per plant, against an average of about 50 workers per plant in California. The designation "one-man cannery" must apply literally to a large number of Virginia's establishments. The effort to find out what it is that Virginia cans on this piffling basis fails in the face of the fact that under almost every commodity her total output is so small as to relegate her to the group of "all other States." Sweet potatoes make up about 10 per cent of her total, and that is the only item of any consequence.

We have just employed the term "average" in connection with the payroll of the cannery. This is quite necessary because of the seasonal character of the industry. It reaches its peak in September, and its low point in March. In 1919, the last year for which complete figures are available, there were 35,692 persons employed in March, and 198,047 in September; while for the entire year the average number of hands was 89,923

THE figures for output shown in the drawings are those for the year 1921. Complete reports for this year, however, are not available; so much of the text is based upon the 1920 census figures for the year 1919. Owing to shorter crops, 1921 was not nearly so big a year in the canning industry as 1919.

Another interesting item is the percentage of female workers. Taking the average number of female hands for the year against the average number of both sexes for the year, Virginia shows the highest percentage of female workers—59.8 per cent. In most cases these women are doubtless members of the proprietor's family. Of the States where canning is on a large commercial basis, Maryland shows 58.7 per cent of the workers to be females, and California 50.8 per cent. For the entire country, the women workers constituted 48.7 per cent of the total.

In line with the seasonal character of the employment in the cannery come long hours during the months when the plant is in operation. About 61 per cent of the workers put in a working week of 54 hours or more; about 48 per cent one of more than 54 hours; and no less than 36 per cent worked 60 hours or more per week—when they worked at all.



Further items in the dollars-and-cents comparison. The areas of the circles are proportional to the amounts which they represent

Every year we eat enough canned and dried goods, as itemized above, to dwarf the Woolworth Building. The cans and cases are drawn to scale, the size they would have to be to hold the poundages which they represent

A Trade that Is Passing

A PECULIAR trade practiced in some parts of Italy is that of the peddler of leeches. So greatly have these little animals lost caste among our own medical practitioners that probably most Americans of the younger generation hardly even know what they are. Their name implies that they are physicians; but they are decidedly of the old school. They were in their glory in the days when blood-letting was the favorite remedy for almost any malady whatever, and when the barber was the surgeon as well.

This little aquatic worm has a sucker at each end of his body, which he uses in place of feet for traveling on land. He attaches first one and then the other to the surface over which he is progressing, alternately lengthening and shortening his body as he moves. With the anterior sucker he also earns his livelihood. In his infancy he is perfectly satisfied with sucking the blood of such low orders of animal life as he finds in his native pool. But he soon gets a taste for the blood of mammals, and finds he prefers it to any other. He has three very sharp serrated teeth like semi-circular saws, arranged in a triangle. With these he makes a tiny wound in the skin, and sucks himself full of blood if allowed to do so. In order that the blood may flow freely, he injects into the wound a chemical of his own manufacture which prevents coagulation, and which incidentally causes a considerable further loss of blood after he has finished his repast unless some measures are taken to prevent it. When used surgically, the leech may be placed inside a small glass tube to insure his taking his lunch from the exact spot desired. It is said that he never carries any infection unless he takes it from a former patient, for which reason it is customary not to use the same one twice. His victim may think him a glutton. But his tastes are really frugal, since one good meal will last him for several months. He is free, too, from many other cares that afflict humanity. Thus the rising death-rate from diseases of the heart does not trouble him, for he has no heart. The question of woman's rights does not fret him neither, for each individual is of both sexes.

In Tuscany and some other parts of Italy the mignattaro or peripatetic vender of these beasts is a fairly regular visitor, making his rounds once or twice a month, usually peddling also one or more varieties of medicine guaranteed to cure all the ills of man or beast, for nowadays there are some who seem to prefer internal medication to parting with their blood.

But, before he sells his wares, he has to catch them; and that, on the face of it, does not seem a very pleasant part of his job, although certainly the excitement of the chase is not wholly lacking. Going to one of the pools in which the leeches are known to abound, he removes all his lower garments, and pulls on a pair of drawers thick enough to resist the attacks of his prey. He then wades in, beats the surface of the pool with a staff, and stirs the water vigorously with one leg. The simple-minded leeches, thinking themselves the hunters instead of the hunted, attach themselves to his drawers in the vain expectation of securing a feast. But the mignattaro deftly removes them first from one leg, and then from the other, and thrusts them into a small bag.

This hunt is carried on throughout the year with the exception of the dry summer months, which are not favorable for the purpose. But the prudent mignattaro will have accumulated a surplus in the spring, which he can sell later. Once caught, the leeches need little attention save a daily change of water, owing to their ability to live a long time without food. The mignattaro sells his wares at retail to private individuals, and at wholesale to pharmacists and to barbers, for some of the latter, no longer letting blood with their razors, both sell and apply leeches. Indeed, leeches may occasionally be found for sale by Italian barbers in this country. Formerly the mignattaro would sell his leeches for as a little as a cent apiece, or even three for two cents. But now he gets several times as much. When the pharmacist sells them, he, in turn, makes a profit of several hundred per cent, but doubtless needs to do so, since the ungrateful animals often die on his hands.

Many eminent physicians in Italy prescribe leeches for their patients, and the use of them is very general, especially in the country. During the last epidemic of influenza they were particularly in vogue. And a single mignattaro is said to have made a snug little fortune at that time, selling thousands of the leeches at a franc apiece. But the influenza does not come every year; and the ordinary profits are not enough to attract the younger generation of Italians. It seems, therefore, as if a few more years might find the trade of mignattaro quite extinct. And what will the poor leeches do then?

Copper Qualities

COPPER sheet, according to a circular on copper by the Bureau of Standards, is made from cast cakes, three or four inches in thickness, by hot or cold rolling. For tanks, etc., these cakes are hot rolled nearly to size, pickled in acid and then cold rolled down to the final size. But for the smaller gages of sheet copper cold rolling is resorted to, the furnace cake being first hot rolled to about one-quarter inch, annealed, pickled and rolled down to size cold with intermediate annealing.

Seamless tubes are made by casting a hollow cylindrical billet and drawing down cold over a mandrel, or by piercing a solid cylindrical billet. This is done at a temperature of 850 degrees Centigrade. The pierced tube is quenched in water and further reduced by cold drawing over a mandrel.

In welding copper by the oxyacetylene process a larger size blowpipe is required than for iron, but with a flame of lower temperature. Copper cannot be cut by the oxyacetylene flame, however. In arc welding, two or three times the power is required than for iron.

Copper may be hardened by mechanically working it or by adding some alloying element. The "tempering" of copper by primitive peoples, which is erroneously held by many to have been a lost art, is brought about by hammering. Copper dissolves about 11 per cent of tin, and up to this limit is hardened by its addition.

The corrosion of copper consists in the formation of a thin protecting layer of oxide or green basic carbonate, but in marine atmosphere an oxychloride is formed. Some small pits that may form are attributed to local electrolytic action caused by the presence near the pit of some substance electropositive to the copper. This may possibly be copper oxide or some of the basic oxidation products of copper. Hard copper is more corrosible than soft, the former corroding up to five times as fast as the latter.

Our Reserves of Energy

The Heat and Power of the Future, Seen from the Brighter Side

By Leo G. Hall

EVERY little while some well-intentioned alarmist tells us that our fuel resources are within twenty or thirty years of exhaustion. He then draws a lurid word picture of cold homes and stilled wheels of industry. Consequently there is a widespread popular belief that the next twenty years, or fifty at the outside, will see us in the cold unless we take immediate strenuous measures to utilize other large supplies of energy.

Now this is mostly nonsense. Without repeating statistics already published at length, Mr. Hall calls attention to some general considerations showing that we will never exhaust our available supplies of coal or even suffer from a serious fuel famine; and that even if we knew we should have to face definite exhaustion of fuel resources five years from today, we could prepare for the jump, in the present state of development of the arts involved, with no serious suffering, and with much less flurry than we underwent during the great war.—THE EDITOR.

ACCORDING to authentic recent information, the world's known anthracite resources are about 30 per cent exhausted. The known bituminous resources are about 7 per cent exhausted. In addition to this there is a supply of lignite as yet practically untapped which is greater than the bituminous supply. It is about a hundred years since coal supplies began to be tapped to any great extent. In that period about a sixth of the known coal supply has been used. How much unknown coal is stored away no one knows. But there is certainly a considerable amount in the unsurveyed reaches of Siberia, China and Africa.

Additional to all this, there are great peat bogs on all of the continents which, with the improved methods of unwatering now being put into use in Germany, will form still another fuel reserve. I do not mention oil and natural gas, for they have never formed an important part of our energy requirements, and they are already apparently within measurable distance of exhaustion.

We are pyramiding our fuel demands year by year. Every year sees more used than the year before. If that process keeps up indefinitely, it is, of course, only a matter of time before supplies are exhausted. But it will take much more rapid pyramiding than has occurred in the past to exhaust the coal, let alone the lignite and peat, within the life time of any person now living.

Economic factors will, however, gradually enter the field and stop the use of coal for fuel long before the supply is exhausted. The coal we have mined to date has been that within easiest reach and which can be mined at lowest cost. As these easily mined fields are exhausted, the cost of coal will go up. This rise in price may be retarded somewhat by improved methods of production, but it will none the less go on. Gradually the cost of power from coal will exceed the cost of power from other sources not hitherto developed because not hitherto considered economically worth while. And as fast as these other sources of energy become more worth while than coal power, they will supplant coal power. The cost of coal power does not need to go very much higher before very large blocks of this other energy are thrown into competition with it. It will interest us here to see what other large supplies of power are available.

The first and most obvious of these is, of course, the power of rivers and waterfalls. Engler, I believe, has estimated that the energy which might be taken *economically* from these waterfalls is sufficient to replace 60 per cent of the world's present coal demands. Note that word *economically*. Recent developments of efficient low-head turbines have already brought a much larger portion of the world's watercourses within the economic fold and Engler's estimate is already out of date and too low. A large part of the world's potential water power is of the low-head type. And Engler's figure should be increased by about half to include this.

With a comparatively small increase in fuel price, other developments not included in Engler's estimate by reason of high cost will become economic competitors of coal and will be developed. Developments now carried to only a quarter or a third of potentialities will be increased to full capacity when the price of power warrants it. All in all, with the price of fuel but little higher, there will be power economically available from rivers and watercourses not far, if at all, short of the total fuel-power requirements of today.

While it has been objected that much of this power is too far out of the way for use, it is also one of the laws of economics that "if the mountain won't come to Mohammed, Mohammed will go to the mountain." But no wholesale changes of seat of industry would be necessary. High-tension transmission of current for a thousand miles is within the range of present technique. Its commercial transmission over several hundred miles has been an accomplished fact for many years.

In addition to the potential power of rivers and waterfalls, there is a vast store of perpetual energy in the tides. Recent developments of efficient low-head turbines have rendered the development of tidal power economic, and several very large tidal-power plants are under construction in Europe today. The high tides of Nova Scotia are also being utilized in a considerable development in progress.

It is hard to say how much power is available by this means; but it is safe to say that a majority of the world's tidal estuaries and narrow mouthed bays are capable of development so as to furnish their thousands of horsepower each. Probably power can be developed from tides in excess of what can be developed from rivers and waterfalls. And a large part of this power could compete in the open market with coal even at present prices.

It is at any rate certain that the above two sources of power alone are more than sufficient, if completely developed, to replace the world's entire coal consumption and meet growing demands for many years to come. But we have not begun to exhaust available sources of energy.

How about fuel for heating and the replacement of liquid fuel for internal combustion engines? The answer to this question lies in sun power. I do not refer to the cumbersome machines which we are wont to associate with sun power, but to nature's process of storing up sun heat in the sugars, starches and cellulose of plants, and the utilization of it by converting these substances into alcohol which can be used for fuel. Alcohol can be produced today at a cost, power unit for power unit, about a third of the cost of gasoline. It can be used in any gas engine with a small adjustment of the carburetor.

Germany today produces her millions of gallons annually of fuel alcohol, almost entirely out of waste products. We in this country are accustomed to associate alcohol with fancy prices, because government restriction has made the cost high. But we are the only large nation that is so restricted; and the time will come when we shall have to put ourselves on a par with the rest of the world and permit unrestricted manufacture of alcohol. Already our industries have suffered much by alcohol restrictions, even before the recent hysterical prohibition legislation.

The beauty of alcohol as a cheap fuel is that it can be made from garbage, sawmill waste, the rank growths of marshes, weeds, cacti, sage, and from other organic wastes, which are now heavy liabilities. Within the lives of the present generation the world will be harvesting its fuel crops as regularly as it now harvests food crops; and alcohol will be produced far in excess of present gasoline manufacture. Wherever the sun shines there is potential alcohol.

There are still other sources of power which will be put to use on a large scale as economic considerations dictate. We have most of us read of the solar heat machines which are used in Egypt to produce power for pumping purposes. These are economically worth while in Egypt because coal is there scarce and expensive. They will become worth while and be put to use on a large scale elsewhere as fuel becomes more expensive. Recent developments in the art have also brought the cost of solar power equipment down to the point where it is very nearly an economic proposition in parts of the United States today. The near future will see commercial sun power plants in operation here. And undoubtedly we will most of us live to see giant plants in operation on the cloudless deserts of the southwest, transmitting their power both to the coast and to the great cities of central United States over high-tension lines at from one to two million volts, or perhaps by wireless.

The *average* intensity of radiation received by the earth's surface in Arizona and Nevada during daylight hours for the entire year amounts to about one-third horsepower per square yard of surface, or a million horsepower per square mile. Probably not more than 70 per cent of that can be practically realized. But even at that, a single Arizona County could produce power enough to supply the entire power requirements of the United States. I believe that our present demands are about 15,000,000 horsepower. Probably the consumption of the whole world is not in excess of 100,000,000 horsepower. Yet there is solar energy going to waste on the deserts of the world sufficient to supply several billion horsepower continuously; with the proper storage and transmission facilities. It could be done today. It would be done today, if the demand were sufficient.

There is scarcely a district in the world that is not within transmission distance of large supplies of tidal power, river power or solar power. And there are still other large available supplies of energy.

During recent fuel shortages several successful wind-power plants were built and operated. Recent advances in the art have made it possible to do away with the old cumbersome stiff windmill and substitute a sort of wind turbine which is light and strong, and will operate efficiently under a much greater range of wind velocities. Improvements in generating apparatus make it possible to generate and store a uniform current from an exceedingly variable source of power. The time may come when every household has its wind plant on the roof, with storage batteries in the basement, to furnish power for lighting, heating and cooking. It is economically practicable even now, if people only knew it. When there is sufficient economic pressure, firms will go into the manufacture of apparatus for that purpose, and the thing will be done. At any rate, here we have another large available supply of energy.

Then we have the internal heat of the earth itself to draw on. There are many hot water springs, steam vents and hot gas vents in different parts of the world. Exceedingly high temperatures are reached in some places by simply drilling a few thousand feet. In Italy a natural steam vent has been improved by drilling and then harnessed for practical use to furnish 16,000 horsepower continuously. In Montana there is a nursery which derives part of its heat from natural hot water springs. Most of the mountainous or volcanic regions of the earth could probably be made to furnish continuous energy in considerable amounts by tapping them.

I have pointed out above, sources of power which could be developed today, without any further advances in the art, if conditions were such as to warrant their development wholesale. These sources would together certainly supply the power energy demands of our globe many times over.

I have not yet mentioned promising possibilities which are not yet developed—vast stores of power which we know exist, though we have not yet found the key which will unlock them. There is the power locked up within the structure of the atom, which radioactivity has shown us. This is a store so great as to stagger the imagination. Any year, almost any month, may easily announce the "Open Sesame" to this store house.

Experimental work is going forward with relation to making artificial fuel. That is, finding an endothermic catalyzed low-temperature reaction which will take place slowly under the sun's heat during summer months and which can be reversed rapidly at will in the winter months with the evolution of the stored heat. Such a discovery would render the cumbersome and expensive solar machines unnecessary. Some progress has been made along this line.

(*Continued on page 215*)

An Automatic Exposure-Meter

By Dr. Alfred Gradenwitz

CORRECT exposure is, of course, an essential condition of any satisfactory photographic work. In fact, while there is some latitude in this respect and while mistakes in gaging exposures can, to some extent, be made up for by skillful developing, a large percentage of both amateur and professional work is spoiled by improper exposure. The main difficulty in this connection is due to confusion, the brightness of some given portion of the objects or scenery to be photographed being appreciated, rather than that of the entire picture as a whole.

Thus suppose the water-scape herewith is to be photographed, the circular frame being, to begin with, left out of account. The time of exposure should be so chosen that the darkest portion of the picture, the fringe of the forest in the background, is reproduced with some detail. On the other hand, exposure should not be prolonged sufficiently for the brightest portions of the picture, the sails, to be over-exposed so that the more delicate shading would be subdued in a uniform black on the plate and a correspondingly uniform white on the positive print. Generalizing, the time of exposure should, in any case, be so chosen as to keep the exposure corresponding to the brightest portion of the picture below a given maximum and the exposure corresponding to the darkest portion above a given minimum.

This is the fundamental principle underlying the construction of Dr. Schlichter's new actinometer. In fact, when pointing this instrument, which in outward appearance resembles a small telescope, at the scenery to be photographed, the picture is seen through a blue filter surrounded by three checking sectors, as in our example—a bright, a medium and a dark one. The fourth sector corresponds to complete darkness and is not used for checking purposes.

The checking sectors are so graded with regard to one another as to correspond exactly in brightness with respective degrees of illumination at which under-exposure ends, at which normal exposure is at its median point, and at which over-exposure begins. Accordingly, in a striking manner, they delimit the range of correct exposure. The photometric balancing of the brightness of the picture with the checking sectors is effected by turning the milled ring *a*, and through it the iris stop, so as to have no portion of the picture remain brighter than the brightest, and no portion darker than the darkest of the three checking sectors. In the sample picture here used, which is rather rich in contrasts, the sails should be of about the same brightness as the brightest, and the fringe of the forest about as dark as the darkest checking sector, while the water sheet receives the average tint corresponding to the medium-brightness sector. The adjustment thus obtained is read from the scale *b*. This balancing operation reduces the picture as a whole to a single brightness.

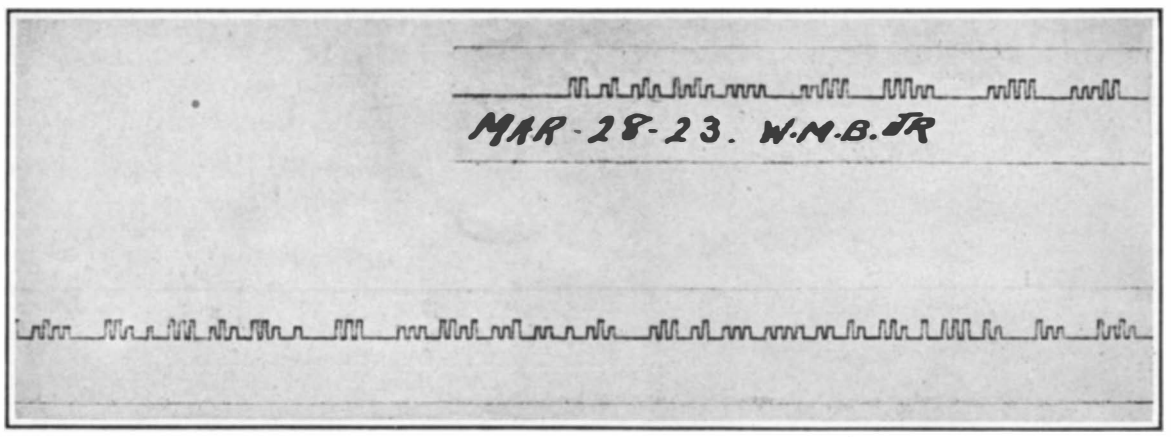
Now, the light serving to illuminate the checking sectors is nothing else but the daylight in the space in front of the instrument. Its absolute brightness can be ascertained by gaging the blackening time of a strip of photometer paper visible at *c* in the rear part of the instrument. The scale-reading on *b* and this blackening time are next adjusted to one another, the ring *d* being turned until the two figures appear beside one another on the left-hand scale. The proper time of exposure is then read from the same ring (on the right-hand scale) at the point that falls opposite the number corresponding to the objective stop used in the camera.

The instrument has the shape of a small telescope and is mostly made of light metal, thus weighing only about 130 grams. Its main distinctive feature, as compared with other actinometers is the elimination of the sensitiveness of the eyes and the direct balancing of the brightness of the picture with the blackening time of the photometer paper. In fact, the instrument constitutes an actual photometer of known accuracy and, accordingly, eliminates all personal equation.

The transmitter that would make the new alphabet applicable alike to cable, land lines and radio

Left: The complete apparatus. *Right:* Typical example of what one sees in the eye of the actinometer, with the reference fringes of varied shading

The automatic exposure meter and the way it works



A specimen of the transmission of the newly proposed telegraph code

Doing Away with Dots and Dashes

By S. R. Winters

SWEEPING revision of the method of transmitting the Morse alphabet with respect to radio telegraphy, land-line telegraphy, and submarine cabling, was recently outlined by Major General George O. Squier, Chief of the Signal Corps of the War Department, in a lecture before the National Academy of Sciences. The modified system of signalling would reduce the varying time-periods of the telegraphic dots, dashes and spaces to a common duration. Dots, dashes and spaces would be distinguished not by duration but by variations in the intensity of the signals.

The different intensities in a dot, dash, or space, under the proposed new system of signalling, would be effected by the use of alternating electric current. Each half cycle or arbitrary multiple of a half circle would represent one of the three individual sending elements, depending upon the intensity. These different intensities are, of course, accomplished at the transmitter. This improved method of transmission has already been subjected to experimental application in submarine cables and a means provided for interpreting the alternating current into understandable signals. Radically differing from the present system of the sending of the International Morse code, in the system being described no two adjacent signals are of the same sign, since each semi-cycle is employed to obtain signalling, affording a dot, dash, or space.

The Code Section of the Signal Corps of the War Department, in applying this novel form of telegraphic alphabet to submarine cabling, discovered that: "Other things being equal, the variations in intensities for each of the three elemental signals are reduced to the minimum on the theory that the minimum possible change of the fundamental wave should be made. An alternating current in the steady state, which amounts to a series of the present cable letters "s" or "n" strung together without space, can attain a speed in any form of telegraphy many times greater than any practical system, for the reason that a single sine wave is transmitted through any form of electrical circuit without distortion of any kind, and, in fact, is the only type of wave that is so transmitted."

In striking contrast is this contemplated system of telegraphic signalling to the method now in force. The powerful radio-telegraph stations, for instance, do not attempt to correlate the actual sending of the dots, dashes, and spaces with the phase or supply of electric current entering the transmitting antenna. The telegraph key is opened or closed without regard for the phase of the antenna current. Thus, in the transmission of one message a relatively large supply of electric energy in the antenna may be interrupted at widely varying values—from zero to maximum, positive or negative. Many of the existing disturbances in the ether, which mar the audible reception of radio-telephone messages, are blamed on this. An abrupt breaking or introduction of high impedances in an electric circuit, using alternating current, produces transient phenomena, ultimately resulting in the flooding of the ether with "mush" or harmonics. Coupled with this condition, is the irregular procedure of operating powerful radio-telegraph stations

(*Continued on page 216*)

The point in Fort Washington Park from which S. F. B. Morse strung his experimental wire across the Hudson

Relics of the 1840's

An Interesting Chapter from the Early History of the Telegraph

By A. A. Hopkins

AS WE walk along Riverside Drive in the neighborhood of 158th Street, New York's beautiful river drive, we look down on what seems to a stranger to be a ramshackle old mansion swept into a circle of retaining wall by some quirk of the tide. Not so to those who live near by, for they know that Audubon spent his last years in the house, and that here Morse carried on many of his experiments in long-distance telegraph transmission.

In 1842 John James Audubon, then 62 years old, purchased a tract of 24 acres far out of the city and on the Hudson's bluff bank. Audubon thought that at last he had an idyllic spot to pass the remainder of his days amid orchards, a babbling brook, and a tiny waterfall. So he named it "Minnie's Land," "Minnie" being the Scotch word for mother. All went well for a time, but the railway clamored for an entrance into the city, and why not take the water level and travel along the river? Soon the beautiful sandy beach was cut through ruthlessly and Audubon had to build a piazza on the other side of his house to blot out the new symbol of civilization. Of course Audubon was advancing in years, but he still painted in a room on the north side of the house where the bay window is now, and here some of his exquisite pictures of birds and animals were executed.

To this house came as a welcome guest another painter of no mean order, although a portrait painter. His name was Morse, and he was dabbling in electrical experiments. The laundry on the south side of the house, on the cellar level, was given him for a laboratory; and even within the memory of men now living have pieces of wire been picked up from this cradle of the telegraph. Dates are strangely absent in the biographies, but it is probable that he had already made his basic invention before coming to see Audubon; at any rate this dingy laundry now entirely boarded up is an important link in the history of long distance transmission. Mr. Reginald Pelham Bolton, a historian of New York, whose garden leads into the contracted Audubon park, took the writer on a most interesting excursion to find where Morse crossed the Hudson with his aerial wires. A walk of about a mile led into neglected Fort Washington Park, and after crossing over the railroad by an open cut, which must have been a triumph of engineering in the early days, we began a search for the rock where Morse stepped his mast. At last it was found, and after the leaves and earth were dug out we were able to photograph it and also the eye-bolts for the guy-ropes some distance away. The mast must have been of great height as the hole in the rock is over two feet in diameter, and while not deep served to hold the mast thoroughly firm and upright, with the aid of the guy-ropes. An early work on the electric telegraph describes some of the difficulties encountered as follows:

"For a long time the dispatches were carried over the river by messengers in boats; but finally, the line was submerged by Mr. Ezra Cornell in leaden pipes, the wire being covered with cotton, and insulated with India rubber. This was November 20, 1845. There were two cables thus formed, and they worked very well for several months, until they were carried away by the ice in 1846. They crossed the Hudson at Fort Lee, some 12 miles above New York City. When these cables were broken, high masts were erected and wire upon them was stretched across the river. Men were in attendance all the time to repair the wire when broken by vessels. It was the custom to let the wires down into the water for vessels to pass and then to draw them up again. This was practicable in tide water, but not so with the inland rivers. The Hudson river at the place of crossing was 2700 feet wide. These masts were constructed under the direction of Mr. Henry J. Rogers, the energetic superintendent of the telegraph. In 1847 another effort was made to cross the Hudson with a cable, and to that end a copper wire, covered with gutta-percha by Mr. S. T. Armstrong, was purchased and submerged by Messrs. T. M. Clark and J. W. Nortons for the Magnetic Telegraph Company. The cable was placed across the river at the foot of Cortlandt Street. It worked for just one day, and was then torn away by an anchor.

The famous Audubon House on Riverside Drive, now left down in a hollow far below the permanent grade, and falling to ruin. In this house Morse did much of his work upon the telegraph

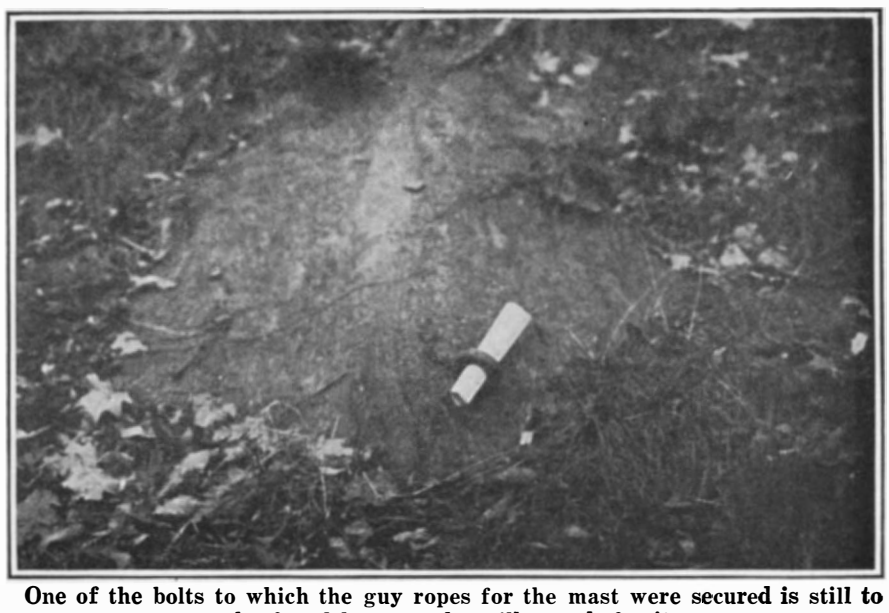
"On the lines constructed by Mr. Henry O'Rielly, throughout the great west, many rivers had to be crossed, over which the wire was stretched. The widths of these streams were from 1000 to 3000 feet. The first crossing was that at Wheeling, over the Ohio river, 1300 feet; the next was that over the Ohio at Louisville. The latter was one of great expense."

So the railway and the telegraph were early placed in close relationship; Morse's mast overlooked a gigantic engineering work, for the time. This, the only railway into New York proper, was for a long time along the Hudson, the trains running through Eleventh Avenue to the depot at 30th Street; and here Lincoln's body was brought through the cut and past the Audubon House, and along New York's "back yard" as it were. Much of New York's freight, especially foodstuffs, still comes in by this route, and one passenger train a day in each direction ran until the efficiency brought on by the war rendered it unnecessary thus to protect the franchise. Audubon himself lies buried in the eastern section of Trinity Cemetery, a few hundred feet away. The Audubon House should be preserved as a monument to a great naturalist and a great inventor, but the ravages of time will soon wipe out this very interesting landmark.

Something About Calories

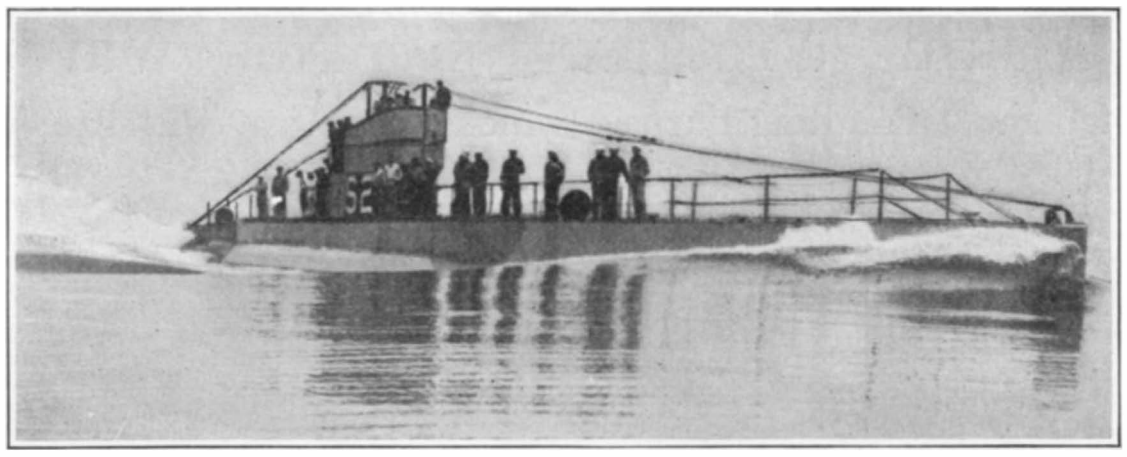
WHEN calories are mentioned in nutrition, it is from the point of view of food fuel value. The caloric value of a diet is a factor of great importance in nutrition. Frankland (1866) was the first to determine this for various foodstuffs by oxidizing them in a calorimeter. He did not express the results in "calories" but rather as "heat units," which, however, had the same value. Stohmann (1879) and Rubner (1883) were apparently the first to use the term calorie as it is now applied in the science of nutrition. Rubner made three outstanding contributions regarding the calorie in nutrition: (1) He applied its present-day meaning to the term; (2) he determined the caloric value of protein, fat and carbohydrate, figures which are widely used in determining the energy content of a diet; (3) he drew the distinction between the absolute and physiological heat values of foods. By absolute heat value he meant the amount of heat yielded by a substance when oxidized in a bomb calorimeter; the amount of heat produced by the substance in question when burned within the animal body he regarded as its physiological heat value. These values may or may not be identical, a fact which is of fundamental importance in the science of nutrition.

Calorie as a mere word explains nothing. It is a symbol for an idea, however, which, as we have seen, has undergone changes brought about by the development of several sciences. Ancient and hazy notions regarding the phenomenon of fire and combustion first contributed to this concept, placed on a firmer foundation by the clarifying influence of Lavoisier. The broad generalization regarding force in nature, receiving its impression in the law of the conservation of energy, played a decisive rôle in the evolution of the idea. The history of the calorie in nutrition, therefore, is wrapped up in the history of nutrition itself and the fundamental natural sciences upon which this branch of knowledge rests.



One of the bolts to which the guy ropes for the mast were secured is still to be found by one who will search for it

A Flexible Clutch for Marine Diesel Engines



The United States submarine S-2, driven by the new clutch that engages and disengages in motion, just like an automobile clutch

AMONG the new features introduced into United States submarines recently completed is a new type of flexible friction clutch. The basic principle involved is that of the application of friction between two grooved surfaces, one being the inside of a drum and the other, the moving surface, being a series of shoes moving radially from the center of rotation. The convoluted surfaces are to give increased friction in a minimum of space.

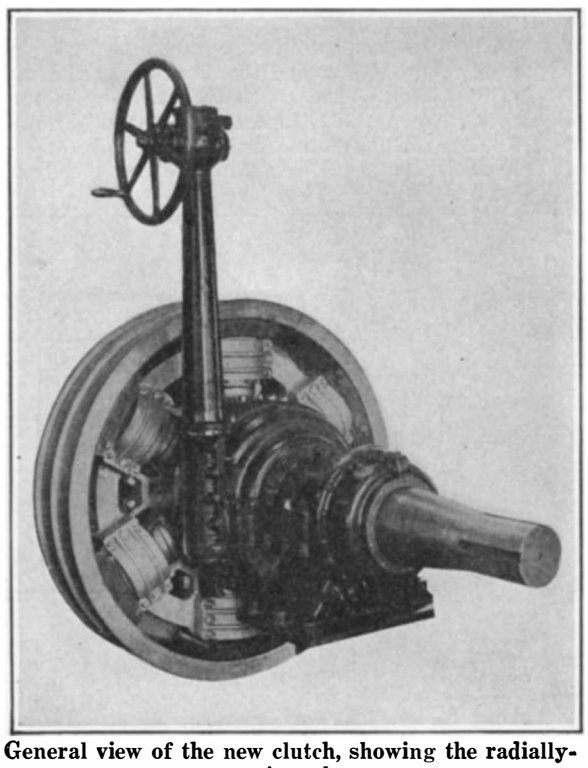
The special problem arising in submarine operation, at which the new clutch is directed, is the need for a connection that will allow flexibility in case either the motor or the engine should be subject to misalinement, following any deformation of the ship's structure from her conditions, pressure when submerged, or wear in the bearings of either of the main elements. It was also necessary to have a connection that would absorb or deaden vibrations in case the flywheel of the engine, acting in opposition to the rotating weight of the electric-motor armature, should introduce torsional vibrations in the intervening shafting, resulting in crystallization and breakage. Also there was needed a connection capable of engagement and disengagement while under way.

During the war the problem here stated was acute, but was solved only in a temporary fashion, by use of a clutch of the multiple jaw type, in which the design was held down to the simplest possible standard to facilitate manufacture. There were in this clutch forty or more jaws, to make engagement possible with only a slight amount of turning to get the jaws into alinement. The new clutch is designed to transmit normal load at about 1000 revolutions, with 50 per cent overload capacity. It was first tested in the United States submarine S-2, one shaft retaining the old multiple-jaw clutch while the new one was mounted on the other. The vessel was sent to sea under the most severe weather conditions, with orders to stay out for 48 hours, and to disengage and engage the clutch at regular intervals. This was a sort of authorization to break the clutch if it could be broken.

The new clutch came through this ordeal with flying colors; and it has since carried the S-2 on a voyage of 8600 miles from Portsmouth, N. H., to Hawaii—the longest straightaway trip by a submersible. The contractors, as a result of this, have been instructed by the Navy Department to equip all subsequent submarines with the new clutch.

To appreciate the importance of having, on submarines, a clutch that shall act substantially as does the clutch on an automobile, it must be noted that when coming to the surface from a submerged run the vessel, if equipped with a plain jaw clutch, must apply the brake to the propeller shaft in order to bring the jaws in line with each other before engagement. In the presence of an enemy this loss of time may be fatal. Vice versa, when diving, disengagement can commence before actually stopping the engine, the motor got under way in advance and engaged without stopping the propeller, again saving valuable time.

Referring to the drawing, the clutch operates in accordance with the following description. A series of shoes *B* moves radially in piston-like guides *D*, *F* and engages the grooved inner surfaces of the friction drum. *A*. The drum is preferably of hard cast iron, the shoes of soft, and the shoe-carrier *E* of bronze. The guides *D*, *D* connect the shoe and shoe-carriers. The sliding sleeve *P* is connected with each shoe-carrier by means of an adjustable link *Q*, with a pin in each end, and with a helical spring *R* mounted on each link to permit of adjustment in proportion to the load to be carried. This adjustment is effected by



General view of the new clutch, showing the radially-moving shoes

dismounting the cap *F* and removing the guides *D*, *D*.

When the load is engaged, the link first moves the shoe radially outward until the friction surfaces make contact; then continuing in its motion, it compresses the spring until the proper tension is reached, in proportion to the load to be carried. The hole for the pin in the outer end of the links *Q* is elongated to allow play between the link and the shoe-carrier. This relieves the tension on the spring when the clutch is released, and allows the link to pull back the shoe when the load is withdrawn.

When the shoes wear down, the link *Q* can be adjusted by withdrawing the lower pin and unscrewing the lower link *A A*, until the desired length is obtained to compensate for the wear. The friction shoe *B*, carried by the shoe-carrier *E*, is so constructed as to permit sufficient lateral movement to allow it to center itself into the grooves of the rim. The driving member *K* and the driven member *J* are not connected to hold the center rigid, so if the steady bearing *L* by some unaccountable reason drops slightly, the flexibility of the springs will permit the clutch to run still engaged.

The counterbalance weights *B B* offset the centrifugal force of the shoe and shoe-carriers, and facilitate clutch disengagement when in motion. The worm-driven mechanism *N-CC* is used only for large powers. The worm-wheel *N* runs between babbitted surfaces in the casing *M*, and also the shifting sleeve *O*. It is not necessary to run this clutch in an oil-bath, though liberal lubrication is required in order to assure the proper overload-slipping regulation.

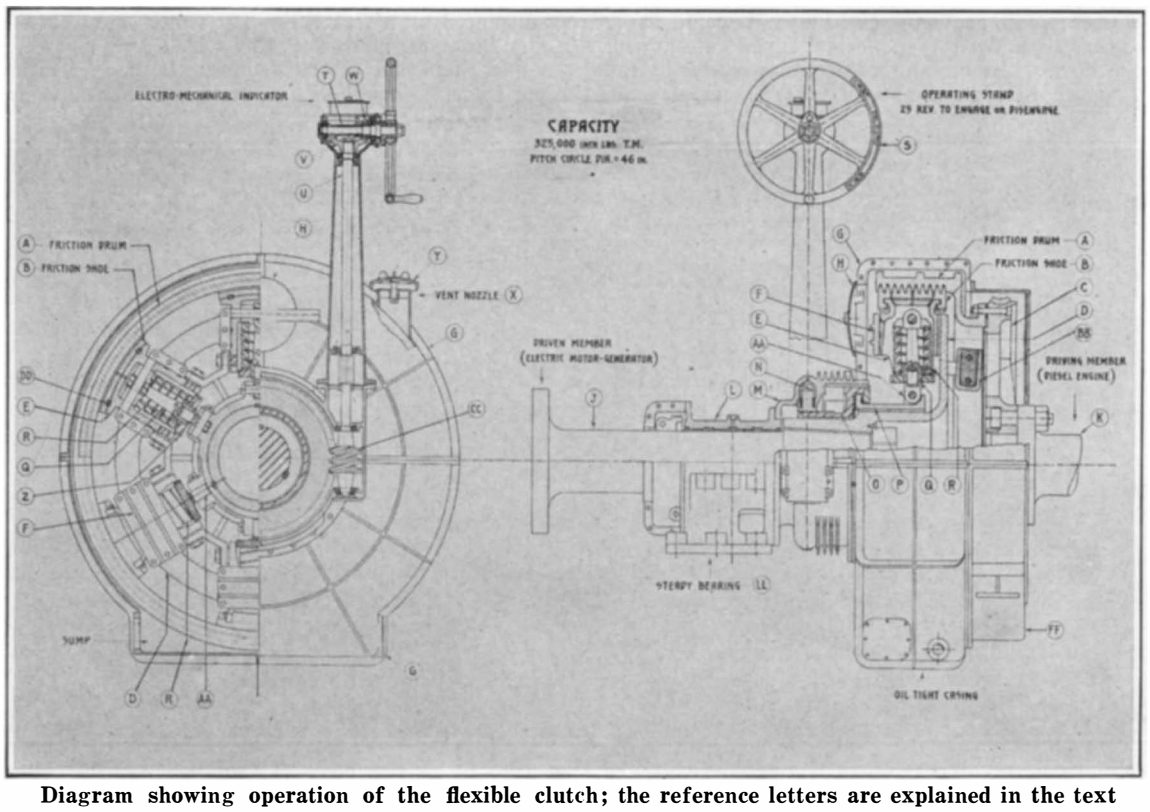


Diagram showing operation of the flexible clutch; the reference letters are explained in the text

Friendly Germs

OUT of about two thousand kinds of bacteria only about one hundred are believed to be harmful. Without the other nineteen hundred life on the earth would soon die out. We, as well as the animals whose flesh we eat, derive all of our sustenance from the vegetable world. Plants require that the soil should contain humus, and humus is brought about by the decay of other plants, which in turn is caused by bacteria, or germs. Without humus, plants establish themselves very slowly, so that if we were to kill all bacteria no more decay would take place. The soil would soon be exhausted and we should all die of starvation.

In a more ordinary way there are many bacteria which are of use to us every day. They produce vinegar. Lactic acid germs give the flavor to butter. Germs help make cheese. They help digest the food in our stomachs. And, finally, they cause juices to ferment into alcohol, even in the United States with its adverse legislation.

Harmful germs of many kinds are always in our systems, and this causes many people to worry, often unduly. The fact is, they cannot possibly be eliminated. Even if it were possible to get rid of them we should be in danger of killing with them the many good germs we must have in our bodies in order to live. The first germs our most carefully protected food meets with are ptyalin and epilepsin, which are always in the saliva. Without them we should all be chronic dyspeptics in a short time, for they attack our food in a most satisfactory part of digestion. Therefore, efforts to keep the mouth "germfree" with tooth-pastes would be unsafe even if they could succeed. However, when the germs are destroyed by the dentrifice a new supply is very soon brought in from the saliva glands. And through the breath millions of new germs of the harmful sort come at once. If we keep our bodies in good health, however, germs will give us little trouble. It is only when they are present in abnormal quantities, or when our resistance goes down, that they menace us.

Making Wrought Iron a New Way

A Mechanically-Operated Puddling Furnace which Does Away with Much Manual Labor

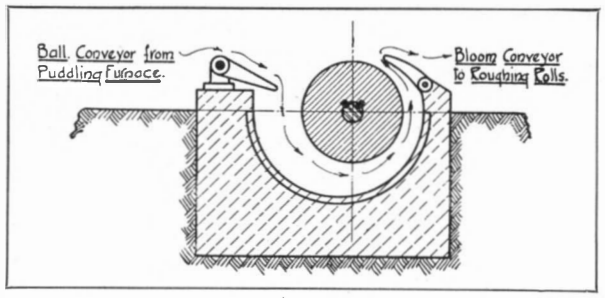
By Prof. Albert Sauveur

SO SIMPLE is the operation required for extracting a small mass of metallic iron from rich ore that the primeval man may have discovered it by means of a fire accidentally lighted upon ground where iron ore existed near the surface. Indeed, the first iron furnace of which we have any record consisted in a single excavation dug on the side of a hill facing the prevailing wind with an opening at the bottom for a draft. The treatment in this crude appliance of some rich iron ore mixed with charcoal resulted in the production of a small pasty lump of iron mixed with slag; that is, of wrought iron. The simple furnaces which later displaced these rough devices were known as forges or bloomeries. A process of this kind was used for many years in the United States, the furnace employed being known as the American bloomery. The operation lasted about three hours. The iron bloom produced weighed from 300 to 400 pounds, and the charcoal consumption was about 2½ times the weight of the bloom.

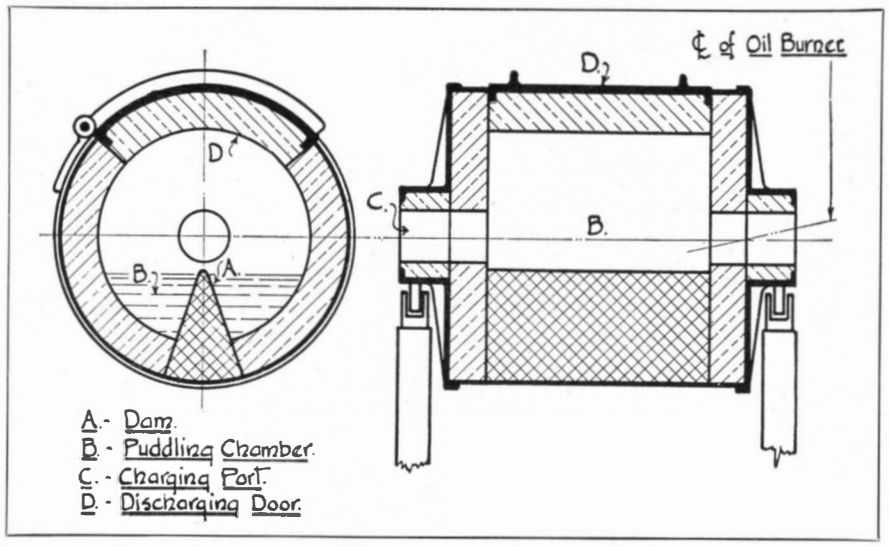
Such processes are known as direct, because they yield a malleable metal in a single operation from the treatment of the ore. They remained the only method of obtaining iron until the fourteenth century, when the blast furnace came into existence. In this furnace the treatment of iron ore with a suitable fuel and with flux yields a product known as cast (pig) iron, which is not malleable. In order to convert it into a malleable metal (wrought iron or steel) it is necessary to deprive it of some of its impurities, notably of the large proportion of carbon it contains, an operation known as refining.

The refining of cast iron was first performed in a simple furnace not unlike the forges and bloomeries used at the time for the direct extraction of iron. The method was called indirect because it required two distinct operations in order to obtain a malleable metal. In these furnaces pig iron was heated in contact with charcoal and subjected to the oxidizing action of an artificial blast which caused the expulsion of the carbon and other impurities and thereby the conversion of the pig iron into wrought iron. These "fineries" remained the only methods of converting pig iron into wrought iron until the invention by Cort in 1784 of the puddling furnace. The greater economy of this new process caused the finery methods to be discarded. In the puddling process the pig iron is treated on the hearth of a reverberatory furnace, where it comes in contact only with the flame and gases resulting from the combustion of the fuel in a separate fireplace, the metal being decarburized and otherwise refined through the oxidizing action of the prevailing atmosphere and through the action of oxides of iron introduced for that purpose in the form of a furnace lining known as "fettling," and of additions to the charge of suitable mill scale. From 400 to 600 pounds of gray pig iron are generally treated in the modern single puddling furnace, the operation lasting about an hour and three-quarters and the consumption of fuel (bituminous coal) amounting to as much as about one ton of coal per ton of iron produced.

The operation of puddling is very laborious, requiring nearly constant stirring of the fluid, and, later, of the semi-fluid or pasty mass, in order to promote oxidation and, toward the end of the operation, agglomeration of the metallic particles. As might be expected, early efforts were made to devise mechanical means of replacing this excessive and therefore costly manual labor. These efforts have consisted generally in the design of mechanical rabbles and of mechanical (revolving, oscillating, rocking) furnaces. None of these appliances, however, proved successful and wrought iron continued to be manufactured practically as it was in the days of Cort. These repeated failures at cheapening the cost of manufacture of wrought iron and at increasing the output of that metal led many to prophesy that eventually it would be entirely displaced by soft, mild or low carbon steel, which in the Bessemer converter could be produced in enormous quantities and at low cost, unless some ingenious mind solved the problem.



Conversion of puddled ball to bloom, the arrows indicating the direction in which the metal travels



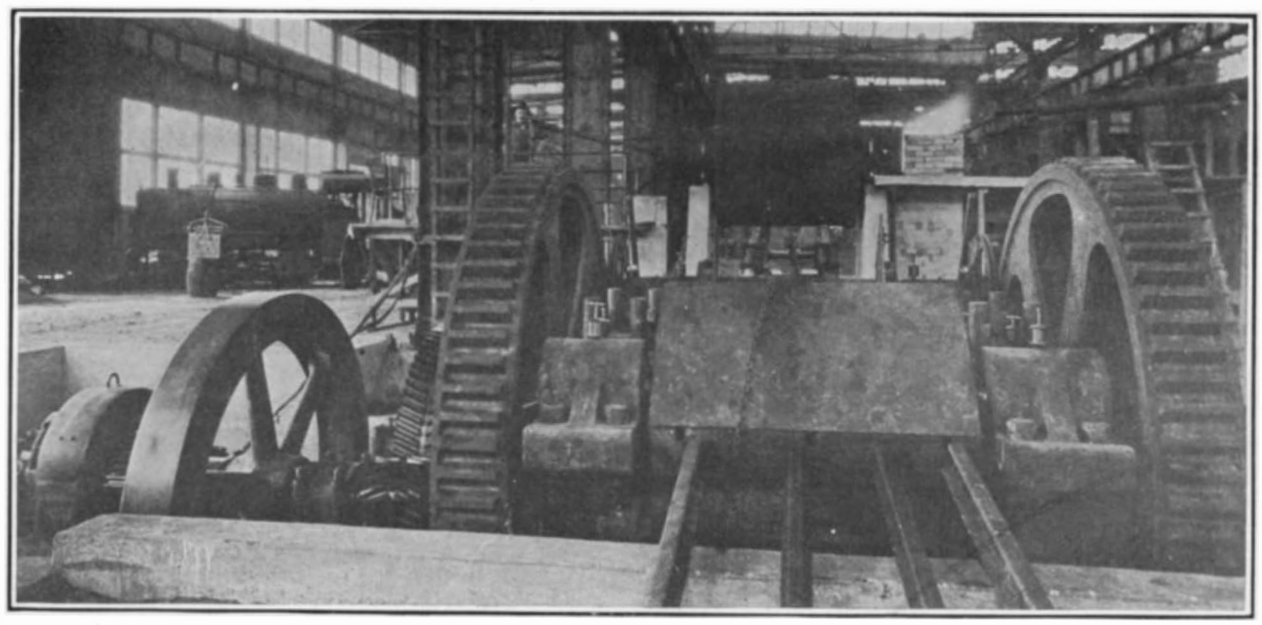
The new puddling furnace shown in cross and longitudinal section

Many consumers and engineers continue to use or to prescribe wrought iron, however, in spite of its much greater cost, which is conclusive evidence that for many purposes it is considered superior to mild steel; and it is also obvious that if the cost of production could be reduced and the tonnage increased, wrought iron would be used much more extensively. There is little doubt but that many are waiting for this to come to pass in order to shift from the use of mild steel to that of wrought iron.

This willingness to use the more expensive wrought iron in preference to steel is due chiefly to its greater weldability, greater resistance to corrosion and greater freedom from brittleness and from binding of joints. This need of long standing for cheaper wrought iron and more of it appears to have been met. In the new process the small reverberatory puddling furnace fired by bituminous coal is replaced by a cylindrical revolving oil-fired furnace in which charges of pig iron weighing some 1000 to 1500 pounds may be treated as against charges of 400 to 600 pounds of the ordinary single puddling furnaces. The pig iron previously melted in cupola furnaces is introduced into the furnace and at the proper stage of the operation a suitable amount of scale is added. The arduous work of the puddler who must during the greater part of the puddling operation vigorously stir or rabble the charge, is done away with all together, being replaced by causing the furnace to revolve back and forth, and the liquid iron to flow over a dam which divides the furnace longitudinally in two compartments. This repeated flowing of the metal over the dam from one compartment into the other causes a thorough mixing of the iron with the oxidizing slag and therefore a quick refining. When the metal comes to nature, *i. e.*, when small solid grains of iron begin to form, the continued motion of the furnace causes the coalescence of these grains into one solid mass which is then discharged through an opening in the furnace provided for that purpose.

This mass of iron mixed with slag, generally known as a puddled ball, is then passed through the rotary squeezer, in which it is compressed and from which it emerges in an elongated form called a bloom. This operation results in a greater compactness of the metal and in elimination of a large excess of slag. The puddled bloom may then be subjected to the ordinary treatments generally applied to wrought iron.

It would be of little avail to have devised a method by which to reduce the cost of wrought iron and to increase its production unless the quality of this cheaper wrought iron was in no way inferior to the product of the puddling furnace. An examination of the new process reveals the fact that the metal is in every way equal to the product of the old puddling furnace, and some arguments might even be advanced tending to show that it is of superior quality. This product has been exhaustively tested and it has been found that it could be made to meet all requirements and specifications demanded of wrought iron for the various purposes to which it is applied. It can be produced practically carbonless. The manganese content may be maintained below 0.4 per cent or indeed reduced to a trace, thus readily meeting the specifications for extra-refined wrought-iron bars.



The cylindrical, revolving, oil-fired puddling furnace that constitutes the basis of the new way for making wrought iron

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Various Arts and to Patent News

A half-pound check protector

A Midget Check Protector

WEIGHING but half a pound, this check protector can be carried in the pocket or tucked in the pigeon hole of an office desk. In spite of its small proportions, as compared with the more conventional protectors, it is claimed to be fool-proof and to give real protection. The hard rubber knob, grooved to make accurate turning easier, has on its edge all the necessary figures, letters and arbitrary marks. Each figure must be set, and at the same time the handles must be squeezed and brought together. This movement prints the figure in red ink and shreds the paper, thus preventing erasure to the same extent as any of the more elaborate mechanisms. Feeding of the check forward for another figure takes place automatically, with the release of the plier handles.

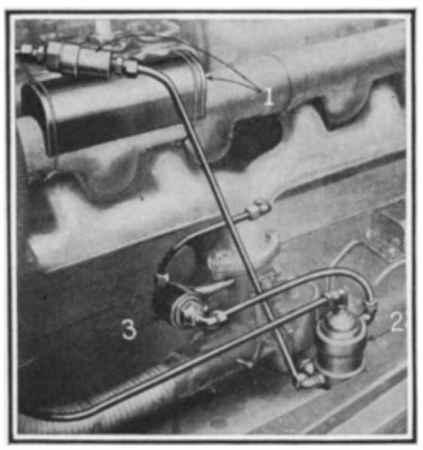
Auxiliary Gas Vaporization on a Large Scale

THOUGH its cycle of operation is rather complex, the gasoline vaporizer which we illustrate herewith does not seem to present any greatly increased probability of getting out of order as compared with the simpler devices for aiding the carburetor; and it has features of novelty which merit description. It starts its operation with an extra tube, let into the top of the gasoline tank, open to the air outside, and extending nearly to the bottom of the tank. As the gas flows or is sucked out of the tank, a vacuum effect is produced in the bottom of this receptacle; and as a result, air enters through the tube described. This air bubbles up through the fluid; and when it reaches the space above the level of the liquid, it carries considerably more gasoline vapor than the air that ordinarily occupies this space.

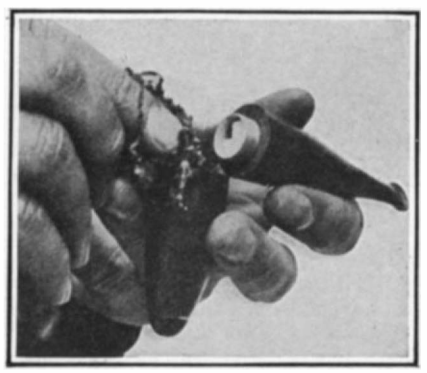
The gas-laden atmosphere from inside the fuel tank, thus abnormally enriched, is sucked through another tube into the "mixer" and past the "stove," which are jointly numbered "1" in our view. The stove encircles the exhaust pipe, in the familiar fashion. The hot vapor thus provided is led next to the gasoline heater "2." This unit has an inner and an outer compartment. Into the inner one passes the liquid gasoline from the fuel tank or the vacuum tank, as the case may be, on its way to the carburetor. Into the outer one flows the hot vapor from the mixer. This causes the gasoline en route to the carburetor to be materially heated, so that on reaching the carburetor it vaporizes more promptly than is usual.

The hot vapor which is responsible for this is not yet through its work. It passes from the heater to the distributor "3," which is attached to the carburetor under the butterfly valve. When this valve is open, all the hot vapor enters the carburetor in perfect form for combustion and forms part of the mixture fed to the engine. When the engine is running idle with the butterfly valve closed, a smaller tube carries the vapor direct from the distributor to the intake manifold, by-passing the carburetor.

It is claimed that this arrangement keeps the engine supplied with such a hot, dry mixture at all times that there is no appreciable dilution of unburned gasoline into the crankcase oil; while the elimination of all raw gasoline in the cylinders eliminates the formation of carbon.



The latest wrinkle in pre-heating and general aid to the carbureter



It looks like a cigar but it smokes like a pipe

Straightening Radiator Fins

AUTOMOBILISTS may now provide themselves with a device for easily straightening bent radiator fins and which can be used on any flat fin radiator. The tool consists of three metal teeth held together by a metal handle and in use the teeth are inserted between the fins and twisted from side to side.

Glass for Footballs

A NEW kind of glass, which, if not actually unbreakable, is so tough that it has been blown into a hollow sphere and kicked about as a football without breakage, has been discovered by Dr. Horak, a Czech engineer and inventor. When used in the form of tumblers the glass has successfully withstood the squirting of cold water immediately after being heated to a point where pieces of paper in the tumbler were charred. While the inventor does not claim that he has found the secret of unbreakable glass, he does believe he has found a way to make it possess the greatest resisting power of any glass so far known. It is admirably suited to the making of thermos bottles, which in so many cases have been too fragile. Plans have been made for applying it to gas masks in order to provide bullet protection to the eyes of the wearer, although it will, of course, find its principle use in more ordinary direction, such as for tableware, bottles, etc.

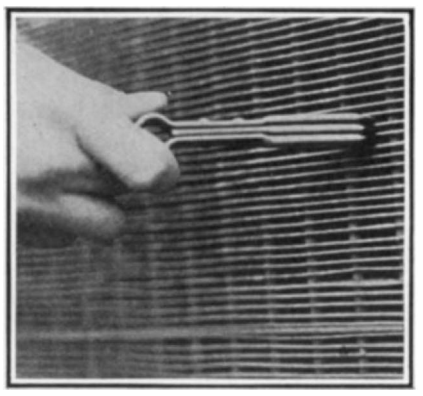
A Pipe in the Guise of a Cigar

THE smoker who prefers a good old pipe to any other form of smoke, but who has an uneasy feeling that it isn't respectable, will perhaps be more at ease with the smoke which we illustrate. This is a pipe, made in the form of a cigar. It comes apart in the middle, and the further end is hollow. This is filled with tobacco, lighted, replaced, and the smoker draws on the assembled apparatus just as he would on a cigar. There is an air vent at the tip to permit this, and if he has been so fortunate as not to have the tobacco go out during the assembling of the "pipe," he may have a smoke in the external dress of a cigar, but possessing all the other characteristics of a pipe.

The Hard-Boiled Hat

COAL trimmers, perhaps, are more exposed than any other workers to the hazard of having heavy objects fall upon them from above; but in a large variety of trades this risk is present to greater or less degree. An unusually successful effort to achieve protection from this sort of thing is represented by the "hard-boiled hat" illustrated. This hat is made of the best grade fiber, in numerous plies, pressed and cemented together by a patented process. The crown is given a truss shape in order to stand great weight, and when advisable is further reinforced with a steel plate. The entire hat is then covered with the best muslin and treated with a patented preparation making it water and acid-proof, fire-resistant, non-conductive of electricity, and long-wearing. The lining of the hat is "hammocked" on the head so that it gives perfect comfort to the wearer, at the same time preventing the hat from being cramped down over eyes or ears in case of an unusually heavy blow. The hat itself is pliable and will fit a head of any shape. It weighs from five to seven and a half ounces, depending upon the style, and is comfortable to wear under all conditions.

Perhaps the severest test to which it has been put in use came through the case of a mine engineer who was struck on the head by a weight of 12 pounds falling 15 feet. Though he was brought to his knees by the blow and the hat dented, his head was not in the least injured.



Simple tool for straightening bent radiator fins

Hardness tester for rapid and serviceable work in the shop

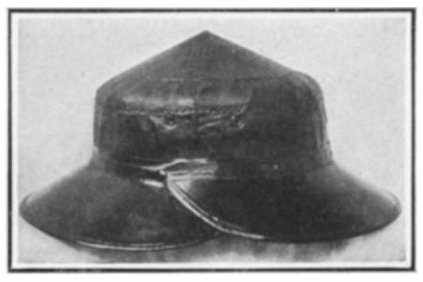
A New Instrument For Testing Hardness

THOSE who have to do with the manufacture of metal parts, especially metal cutting tools and components of light machinery, know how important is the securing of a definite degree of hardness in the material according to its use. One of the disadvantages of the Brinnel instrument is its lack of portability and its unsuitability for dealing with thin and fragile articles. The instrument under review has been designed with a view to overcoming these and other shortcomings of the better known hardness testers.

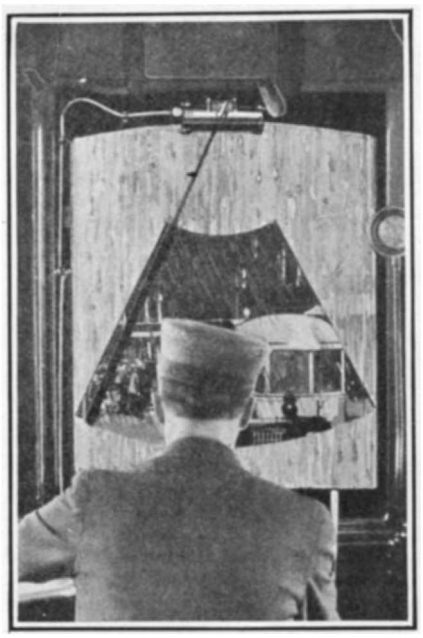
The tester is designed as a pendulum oscillating about its central position. The ball which is of ruby or steel is one millimeter in diameter and is held in a chuck in the center of the instrument. Six screwed weights enable the position of the center of gravity of the instrument to be adjusted to coincide with the center of the millimeter ball. The graduated weight seen in the center can be raised or lowered, enabling the center of gravity of the whole to be brought to a definite distance above or below the center of the ball, the exact distance being shown on a scale. This distance constitutes the pendulum length which for standard tests is one-tenth of a millimeter. With this length a single swing on a very hard surface has a duration of 10 seconds.

It will be observed that at the top of the frame there is a bubble and scale. Having set up the instrument on the part to be tested it is tilted (to the right) so as to bring the bubble to zero on the scale. On release it will swing back, then to and fro till the energy is expended and it comes to rest. The harder the material the longer will it take to come to rest and incidentally the greater will be the first oscillation.

This action enables the hardness of the specimen to be ascertained either



Safety hat for those who work in danger from dropping objects



Applying the automatic windshield cleaner to the trolley

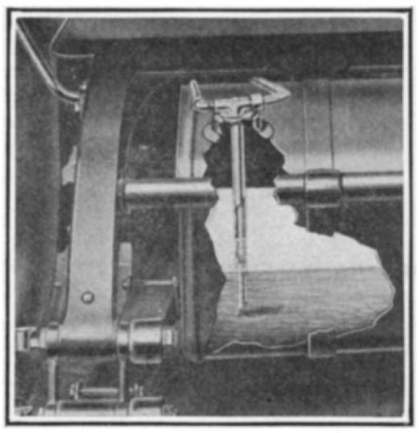
from the magnitude of the first swing or from the duration of a definite number of swings.

In the scale test, the amplitude of the first oscillation may be read off on the scale and the position of the bubble denoting the work done by the ball on the specimen, is a direct indication of its hardness. For instance, 97 is glass-hard, hard steel reads 88, brass 14 and lead 0. The effect of tilting the instrument is to elongate the indentation made by the ball when it is placed on the specimen and the distance it rolls back along the groove so formed is indicated by the scale from which the hardness is deduced.

A time test is more usual, for it gives uniform and concordant results without the necessity of accurate leveling or extreme smoothness of surface. It involves a "time hardness number," which is the time in seconds (stop watch essential) taken in making ten single swings. For material glass-hard the time is 100 seconds, soft steel 20 to 40 and so on down to lead 3.

To take this test the instrument is set upon the specimen with the bubble near the center, or graduation 50, and caused to oscillate through a small arc and the swinging time taken as before stated. The time of the oscillations is, within limits, independent of the magnitude thereof.

The overall size of the instrument is 12 inches and the weight either two or four kilograms. The former has a ruby ball and is used for delicate work, the latter with a steel ball is used for general workshop purposes. The span for clear working is six inches. Articles of an awkward shape can be supported in a ball vise, while flat specimens are simply dealt with on the leveling table of the apparatus.



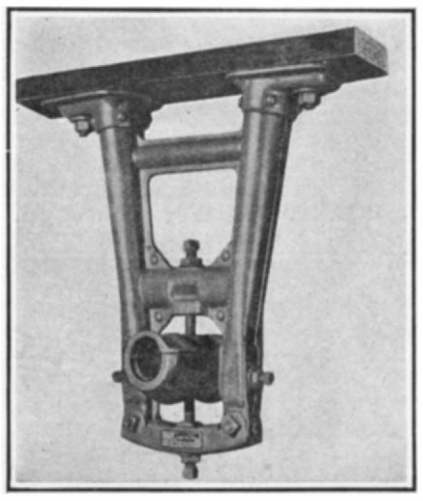
The device that whistles a warning of "low gas"

Clear Vision Ahead for the Motorman

AUTOMATIC windshield cleaners were first devised for use on automobiles, the drivers of which must be able to see where they are going. Vehicles that run on tracks can be run in comparative safety, even when the man in control cannot see where he is going; but when it comes to trolleys operated in busy thoroughfares, it is necessary for the safety of others that he see when it is proper for him to go there. The Cleveland Street Railway Company was the first traction interest to adopt the window cleaner illustrated, giving the motorman a clear view of the road ahead of the car no matter what the weather. Louisville has followed suit, and the device looks like one that merits general introduction. As the photograph indicates, a small electric motor is provided, which keeps the wiping element in constant motion, requiring no further attention from the motorman than the initial throwing of a switch.

For Hanging Shafts

RECENTLY there has come on the market a pressed-steel shafting-hanger of very pleasing lines and good engineering construction. It is of the four-point set-screw type, and has a swing yoke which readily permits the removal of shaft or bearings. The main frame is of two stampings placed face to face, with in-turned flanges extending the entire length of the leg. These flanges provide unusual strength and rigidity. The cross-brace is integral with the legs themselves. All nuts, bolts and set screws are of standard sizes. The general appearance is very good, with smooth frame and rounded surfaces that eliminate dust pockets and projecting parts.



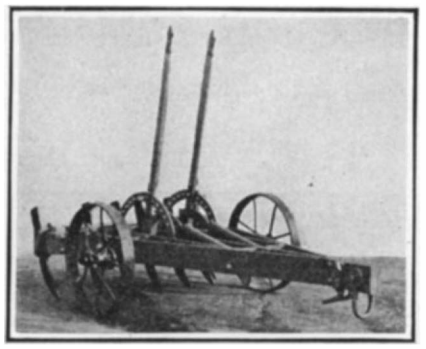
An interesting shaft-hanger of pressed steel

An Audible Gas Signal

WE have more than once described devices intended to remind the forgetful motorist that his gasoline supply is approaching extinction. The latest thing of the sort actually shouts the warning at him. It is of the general type, already noted, having a long and a short upright tube in the bottom of the tank, with gas flowing normally out of the long tube, until the level of the liquid falls to a point such that it can flow out of the short one. But it departs from the usual standard of this type, both in arrangement and in modus operandi. The principal point of difference lies in the fact that the long tube is inverted as pictured. There is suction on the long tube, even after gas ceases to flow through it; and this suction operates a whistle. So when his car begins to whistle at him, the absent-minded motorist looks for the familiar bit of red or orange at the wayside that in motoring code means "Gas sold here."

An Efficient Scarifier

AMONG the season's novelties is a new piece of paving equipment put out by a prominent Cleveland concern that specializes in apparatus for the road contractor. As illustrated, it is seen to be, in general terms, a scarifier. It has been found particularly useful in scarifying subgrades preliminary to mechanical subgrading. It may also be used for all the scarifying found on the average road job, being built very heavy to stand up under such service. Some contractors are using it in place of a rooter plow, and it is finding a place in the maintenance work of many road departments. It carries five teeth; and equipment furnished with the machine includes two complete sets of these teeth, plus one special manganese-steel tooth for extra heavy work. The machine weighs about 1300 pounds, and is furnished for tractor or team hitch.



Another tool for wrecking roads in preparation for repaving

The Spreading of Liquids

AN interesting paper by W. D. Harkins and A. Feldman on this subject appears in the *Journal of the American Chemical Society* for December, 1922. The spreading of liquids both on other liquids and on solids is discussed, and the relations worked out between the coefficient of spreading and the interfacial and surface tensions. The various terms used in the theoretical discussion are defined, experimental methods are described, and the results of numerous determinations given. Those interested will do well to consult the original paper, which is not of such sort as to be effectively abstracted.

A Problem in Thermometry

TEMPERATURE indicated by a thermometer in a medium whose own temperature is changing, presents a lag. Mr. S. P. Owen of the University of Durham has attacked the problem of determining this lag, taking into account the effect of the containing vessel. Complete solutions are obtained for spherical and cylindrical bulbs, with surface conductivity both infinite and finite in both cases. The mean lag in all cases takes the form of a series, of which only the first term has numerical significance.

A Signalling Window for Closed Cars

WHILE the red "stop" light is a good thing, it is not yet recognized by law, and it is likely as any other element of the car to be out of order—the editor drove ten miles, not so long ago, behind a car whose "stop" light was burning continuously. Then, too, nobody but the driver of the car behind knows whether the "stop" light was burning; the casual witnesses of a smash cannot usually see it, and the driver of the car ahead cannot possibly testify, of certain knowledge, that his "stop" light was burning. So with all its merits, this device leaves plenty of room for the good old-fashioned vogue of hand signalling.

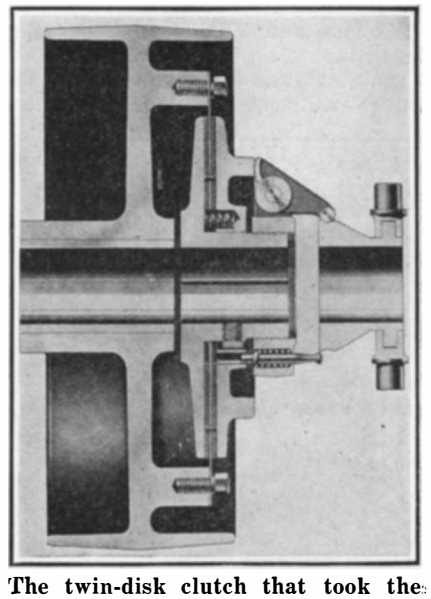
Novel type of window that makes hand signalling from a closed car easy

A Dubuque inventor, Mr. W. A. Erner, points out that the closed car is still a long way behind its open brother in the degree of freedom with which its driver can signal by hand. It's all very well to signal inside the car and trust to the man behind to see the signal through the rear window; but what when the rear seat is occupied? What, in any event, when the driver behind goes into court and states flatly that he was watching, but saw no hand signal? So the inventor in question has given us a signalling window for closed cars. It opens with a push—a mere touch, in fact, of the hand that moves outward to give the signal; and closes again with a pull on a lever or a cord or a strap—or anything else that the owner prefers, for that matter.

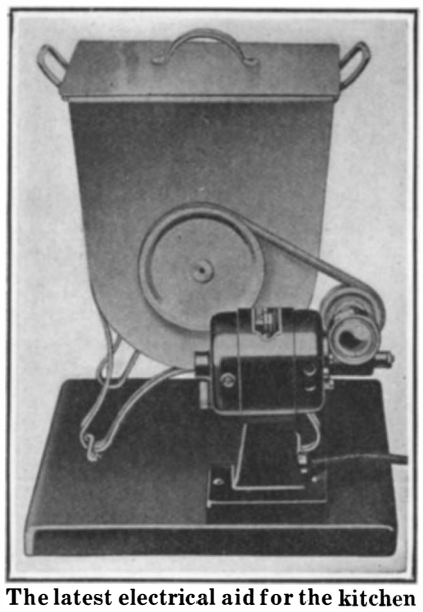
A New Role for the Clutch

COMPELLED to attack a difficult job in its own factory, a Wisconsin concern making disk clutches discovered a new application of their own product. They had to change the location of some of their machines in order to expedite production; and they found the usual difficulties in the installation of countershafts. It was suggested that they install one of their own clutches on each lathe, and drive a battery of eight lathes from one jackshaft. This was done, eight countershafts and eight cross-belts being discarded, and at the same time the fraying of belt edges by belt shifters being abolished for all time.

It is suggested that this new application of the clutch idea will enable every manufacturer to modernize his equipment and cut out his countershaft troubles. The clutch which served so well in the present instance is illustrated. It is a twin-disk affair, so designed that the lifting of one pin permits adjustment up to .005 inch, no tools being required. It gives a positive engagement and does not heat.



The twin-disk clutch that took the countershafts out of one factory



The latest electrical aid for the kitchen —a cream whipper

The Electric Cream-Whipper

AMONG the special jobs about the house for which a special machine is now offered is the whipping of the cream for the morning cereal or the evening pudding. The entire apparatus as illustrated, motor and beater, though purchasable separately, normally comes in a single unit from the manufacturer; but, of course, the motor is available for other work. The labor of whipping cream is considerable, in unfavorable weather, and even under the best of conditions, it is a little job which the housewife will no doubt be glad to get done for her, mechanically.

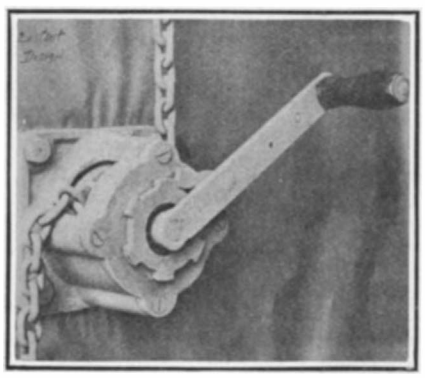
Filling the Radiator

WITH the aid of this neatly designed galvanized metal can or bucket, with a wire reinforcement around the top and equipped with two metal handles, the funnel, splash and drip have been eliminated in the filling of radiators. Note particularly the shape of the spout, curved so as to fit in the radiator opening, eliminating splashing and leaking. The outlet opening is large and with full weight of water behind it, these radiator fillers are exceptionally quick-emptying. The bucket holds about twelve quarts of water.

An Efficient Hand Lifting Appliance

AN efficient form of hand lifting-gear has recently been perfected. The hoist is adaptable, the absence of a drum rendering it equally suitable for a lift of two feet or 100 feet. It can be used on a jib for warehouse and garage work, or can be fitted on board a small craft as a capstan for hauling purposes.

The appliance has a capacity of one ton. An internal gear is mounted on an eccentric spindle, to which a handle is bolted. When the handle is revolved the gear is caused to oscillate in such a manner that the teeth of the internal wheel roll round those of a bevel pinion



Hand-tackle for lifting jobs, with a wide range of application

mounted in the body of the hoist. The internal bevel has one tooth more than the fixed pinion and is thus enabled during one oscillation to advance one tooth, while the chain wheel sprocket, being cast integral with it, is revolved and the load raised.

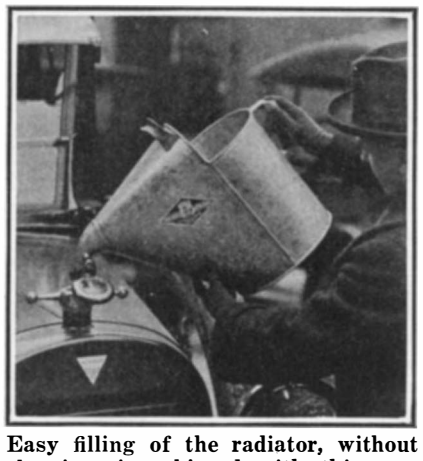
Braking and lowering are controlled by a drum and pawl mechanism, the drum being supported in the front bearing, in which it is free to revolve, but is held in position by pins.

Directly the handle is released, the pawl engages with the teeth of the drum and tends to rotate it against the pressure transmitted to the drum periphery by the load. This friction is quite sufficient to prevent the handle from reversing of its own accord, but the application of a few pounds pressure is enough to rotate the drum. It will thus be evident that the hoist cannot overrun when the handle is released during hoisting or lowering.

Drill and Gas Engine in a Single Unit

HERETOFORE, all power drills, of whatever type, have been limited in their application to the work by the length of an air-hose or of an electric wire. Power for either of these methods must be supplied by an auxiliary power equipment which, on account of size and weight, cannot be cheaply transported, nor located sufficiently near the work to do more than 60 per cent of the drilling to which a power drill could, of itself, be profitably applied.

A Philadelphia concern is now marketing a drill driven by a small gasoline engine. It so combines the action of an air hammer and a gasoline engine that the entire drilling assembly has but two moving parts—the hammer piston and the flywheel member. No crank shaft or connecting rod is employed, and there is no spring or other yielding member. No inlet or exhaust valves are necessary, the rotary valve principle being used, with the revolving mass of the



Easy filling of the radiator, without slopping, is achieved with this specially designed bucket

fly-wheel opening and closing the ports in the cylinder at the proper moments. The down or power stroke of the hammer piston is made with some 900 pounds of explosive force from the gasoline behind it. The flywheel returns the hammer piston on the upward or compression stroke. Approximately 1800 impacts are struck per minute by this single-cylindered bit of ingenuity. Carburetion is by means of a gasoline-mixing valve which permits the engine to work at any angle. While the engine-drill runs at full speed, the operator shifts it from one position to another and to any desired angle without affecting the operation. A single spin of the fly-wheel by hand starts the drill "consistently, in the coldest weather." This looks like one of those things in connection with which the much-abused word "revolutionary" may fairly be used.

Another Phonograph-Record Repeater

THE latest and most simply constructed repeater for playing phonograph records has been just patented and is now ready for distribution. This device, after several experiments, has been proven not only to be practical but to be easily handled by children.

This repeating device for the phonograph needs no adjusting whatever. It just sits in the center of the record over the peg, and does not touch the playing surface nor will it injure in any way the reproducer or needle. Its action is instantaneous with no break or pause between the end of one run and the commencement of the next.

As the needle at the end of the sound

This portable drill carries its own gas engine, and is tied down by no air hose or current connection

box reaches the end of the record, the tone arm is automatically carried (quick as a flash) and gently placed at the starting point.

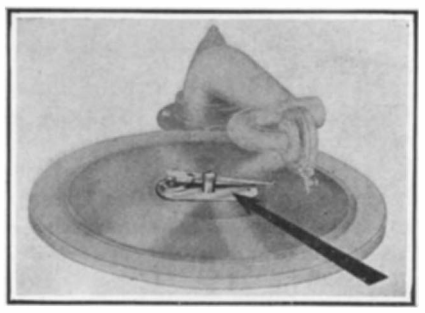
This device is made from sheet steel punchings, consisting of flat base plate, a movable arm which picks the tone arm up at the needle, operating on a cam, which is automatically returned to its original position by means of a coil spring. It is handy and convenient to apply and to use, and its total weight is less than one ounce.

Permanent Automobile License Plates

ANNUALLY in the United States 20,000,000 automobile license plates go into the discard and this means that twenty millions more must be made. The cost of the making is borne, in the last analysis, by the motorist. To obviate this situation, James E. Sellers of Los Angeles has designed a plate which will be permanent, so that the motorist will always have the same serial number. When the plate is first stamped it receives three extra impressions, being in the nature of depressions deep enough to countersink even with the surface the additional smaller plates bearing the date which is subject to change at the beginning of each year. The depression at the left of the serial number is dimensioned to match a small plate bearing the name of the State and the year. Above and below the number are smaller depressions for the application of whatever data the owner desires, such as his name and hometown, or his club. If desired, these spaces may be left blank. The smaller plates are attached securely and quickly by means of small screws with nuts.

A Clean-Cut Gas-Tank Filling Plug

THE necessity of a locked filling plug for the motorcar is an admission that there are few things connected with the automobile, whether valuable or of small



The newest phonograph repeater

value, that are not the object of petty theft. Even gasoline is siphoned from the tank and the unsuspecting motorist, returning at night, is faced with the unpleasant discovery that his tank, which he thought was amply full, has run dry. As gasoline is not a particularly valuable commodity, the addition of a lock to the filler plug acts in practically all cases as sufficient deterrent to send the thief to the next unguarded car for his pilferage. In the case of patents granted to S. S. Sollee of Savannah, Ga., this lock takes on a particularly neat as well as efficient form. The lock, which is of the type having a fluted key, is entirely contained within the removable plug and the actual locking member or lug is placed in the plug in such a way that it is as inaccessible for tampering as is a similar type of lock when mounted on a metal door. When the key is inserted and turned, the plug, which includes the lock mechanism in remarkably small space, is removed. There is no other handle for this purpose than the inserted key, so that when the filling has been completed, the plug reinserted and the key removed, the lock is flush with the surface of the tank, leaving no projections for prying. At the bottom of the filling member, which is tubular and about four inches in depth, is placed a coarse grating which prevents large particles of matter from getting into the tank when it is open for filling.

Window Washing From Within

A SEAT for which many housekeepers will not accept even a free ticket is that upon an upstairs window ledge. Fear of falling makes unpleasant the task of cleaning the pock-marks of dust and soot, spotted by rain, from the outsides of the bedroom window panes. If the housewife will invest in a "third arm," however, the cleaning can be done from within the house. A long handle has at its end an elbow, turned at right angles and to be used facing the glass. Tipping the "fore arm" is the "hand," which grasps a wet cloth, chamois, sponge or rubber. Afterward, a dry cloth is handed to this ever-ready model

Cleaning the outsides of those upstairs windows, without sitting out on the ledge

The "B" battery that stands up instead of lying down, thereby saving much space

servant, for the task of polishing the pane. Nor is this the only unpleasant house-cleaning job that the "third arm" will do. When the now-clean windows "show-up" the dust and grime upon the wall paper a clean cloth can be used in the same tool for wiping down the walls.

Gaskets for the Piston

YOU have gaskets in numerous places about your car where oil or compression might leak out in their absence; you have packing in your pump and shims here and there and everywhere else; but your piston rings are left to make a tight fit as best they can, without any external aid. In the car of the future it may be different; we have seen at least two proposals to make it so. One of them consists in a cork-lined piston ring, the cork lining performing approximately the service of a gasket. This manufacturer makes you buy the rings to get the gaskets; but another is more liberal, and sells asbestos piston seals alone, to be fitted to whatever rings you happen to have on your pistons. The claim is made in both cases that gasoline leaks and oil pumping are much more effectively checked than by plain rings of any design, and that carbon is thereby reduced and power increased. We tried the cork specimens in the editorial Tin Lizzie, and found that at least, they gave no bad effects whatever; on the extent of their good effects we were not certain, since the car was in admirable condition when they went on it.

A "B" Battery That Takes Up Less Space

ENTHUSIASTIC—this is the word employed by the makers of a new and larger type of "B" battery, to describe the reception given the article by the radio audience. The new battery may be called a vertical battery, standing on end and having its terminals on top just like the regulation dry battery. It is four inches by three in cross-section, 6¾ inches high, and occupies less than half the ground space taken by the usual "B" battery of equal capacity. Its voltage is 22.5. It includes in its construction the features of seamless drawn-zinc cans, individual cell insulation, thorough moisture-proofing and improved series connections. Its space-saving advantages are particularly noticeable when a number of units are bound together in compact sets with dry "A" batteries, and used with portable sets. Also for loud-speakers, where four or more "B" batteries are used in series to produce a high potential, the new battery is extremely convenient.

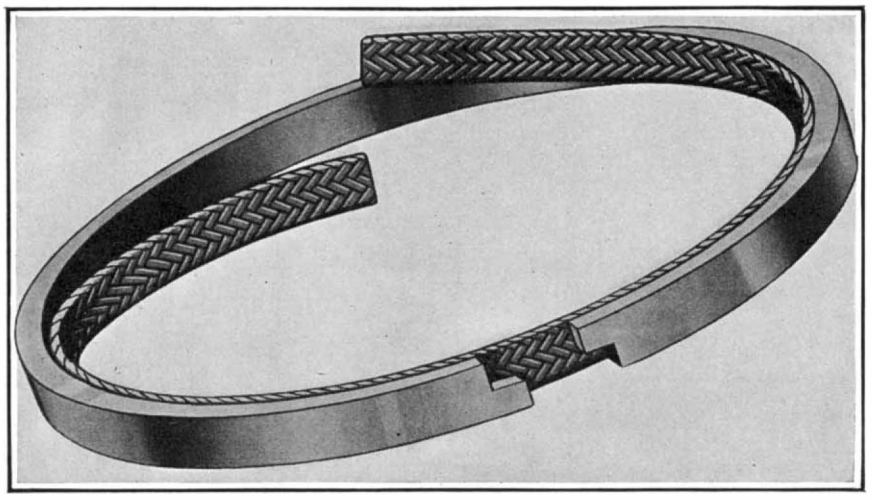
A Precision Balancing Machine

THE illustration shows a balancing machine recently placed on the market, applying the principles of dynamic and static balancing invented by Dr. B. L. Newkirk of Schenectady, so that it is possible to obtain complete dynamic and static balancing by two single corrections, individually measured and located near the ends of the body. When duplicate parts are to be balanced in production, great rapidity can be attained, as static balancing is rendered unnecessary and the operator, who need not be highly skilled, has only a few simplified positive steps to perform.

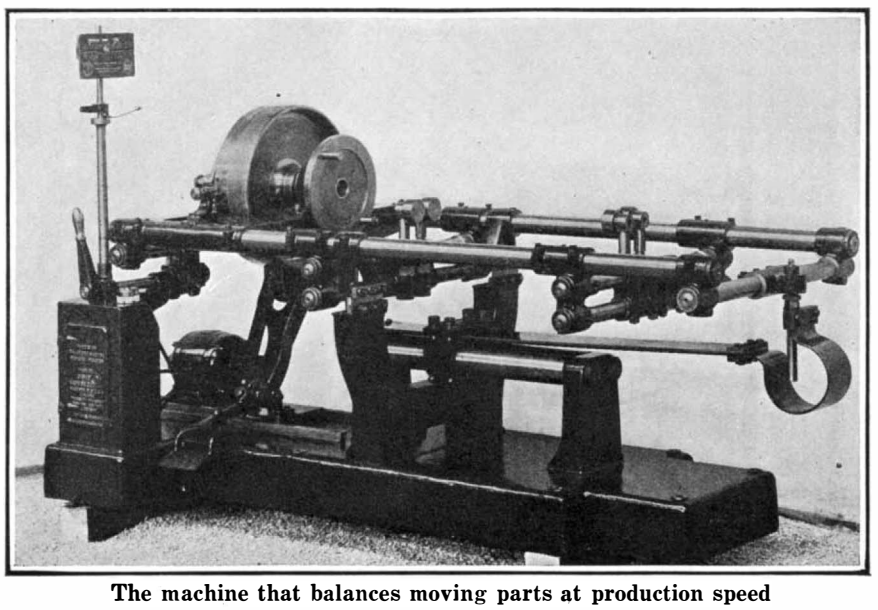
A spring-mounted and pivoted frame carries a special type of headstock and adjustable rollers to support the work. By the form and location of the springs, a free vertical vibration of the frame may take place about the pivot springs as a fulcrum point. All revolving parts, including the rollers which support the work, are mounted on ball bearings. A speed of rotation above the "critical speed" of the frame is first used, and the driving power is then disengaged, permitting a gradual diminution of speed down to and through the free critical speed of the frame. From the observation on the dial indicator, mounted part way up on the column at the left, the amount of the required correction is determined.

A disk at the left of the revolving parts carries a standardized 10-ounce weight, adjustable radially by means of a vernier reading to 0.01 inch. These parts are exactly balanced when the weight is at zero. The disk is adjustable to any angle by reference to a protractor dial.

With the correction thus arbitrarily applied the machine is again speeded up and allowed to pass through the critical speed as before. The second amplitude in this process bears a relation to the first amplitude dependent on the angle between the point of application and the point required. After determining and setting off this angle, a third run will check the result. The machine is universally adapted to a wide variety of work, including balancing crank-shafts, fly-wheels, rotors, pulleys, and other revolving parts. It will receive bodies up to 24 inches in swing and 32 inches between bearings.



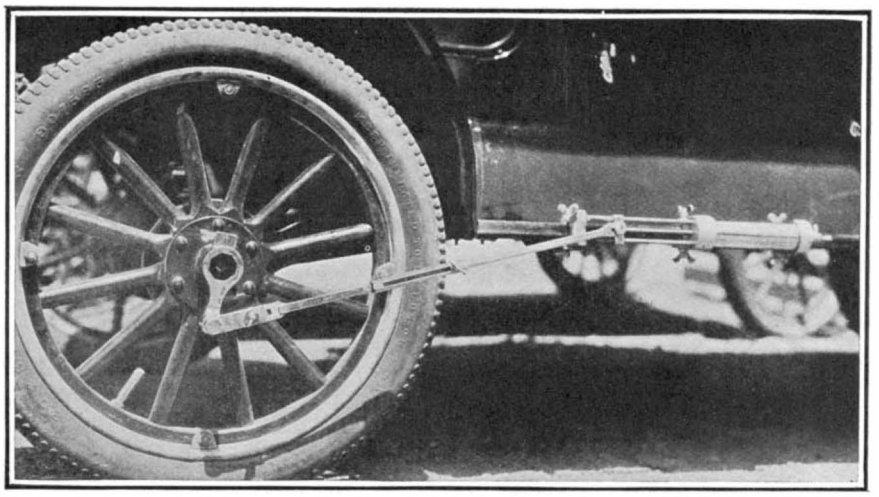
Asbestos or cork linings for piston rings are claimed to cure many of the current automobile maladies



The machine that balances moving parts at production speed

Pump Operated From Rear-Wheel Hub

THIS novel tire pump is operated from the hub of the rear wheel and can pump up a tire in a few minutes.



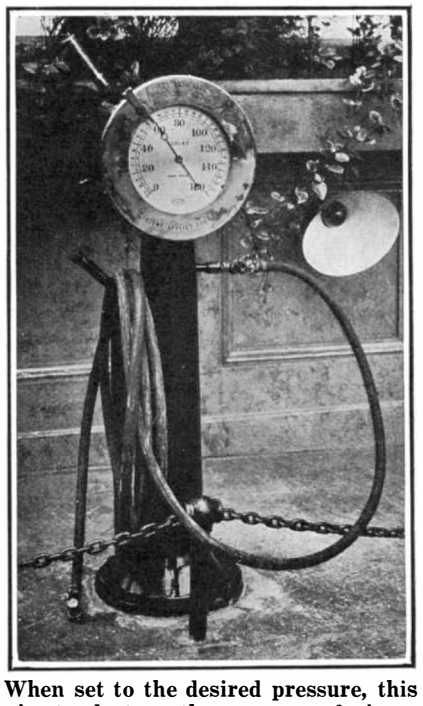
A very handy tire pump operating from the engine through a rear-wheel hub

The pump itself is clamped to the running board. The arm leading from the pump to the hub is adjustable to meet the differences in running-board design; the short arm that forms the driving connection has to be supplied in size and shape fitting the hub of the given car. The pump can be used on 80 per cent of the automobiles now in use. It is clamped to the hub of one of the rear wheels and then this rear wheel is jacked up and the engine started.

Accurate Tire Inflation

A NEW tire inflating device resembles the signal apparatus on the bridge of a ship. On top of a metal standard there is an air gage 8½ inches in diameter, equipped with an indicator attached to a metal handle. By means of the handle, the indicator is placed at the number of pounds inflation desired by the motorist, in the same manner that signals are given to the engine room from a ship's bridge. As soon as the indicator is placed at any inflation point, the air is released into the tire. When the desired pressure has been attained, the air is automatically cut off from the tire valve.

The air inflator consists of a reducing air valve working in conjunction with an air gage. The indicator may be set for any pressure, from that required by a bicycle to that of a truck tire. It registers the pressure from the time the hose is applied to full inflation, eliminating the necessity of one or several tests with a small hand gage.



When set to the desired pressure, this air-stand stops the passage of air as soon as that figure is reached in the tire

The Service of the Chemist

A Department Devoted to Progress and Achievement in the Field of Applied Chemistry

Conducted by ISMAR GINSBERG, Chemical Engineer

New Source of Nitrates in South Africa

ACCORDING to the *South African Journal of Industries*, a new source of nitrates has been located on the Matsap Pan, situated in the Hague district. This Pan is remarkable in that it consists of an underground store of nitrate-bearing brine. Analyses of the brine from several boreholes showed that over 4.5 tons of actual nitrates, mostly sodium nitrate, are to be found in every 20,000 gallons of brine.

Catalysts in Glass Making

FLUORINE and antimony have the curious property of altering the thermal expansion of glasses to which they are added. They appear to act in a catalytic manner as no fluorine remains in the finished glass, and although about 1 per cent of antimony may remain, it appears to be held physically rather than chemically. It is volatilized from the hot glass during working, is dissolved from it by boiling water and even more so by sodium tartrate and hydrochloric acid.—*Chemiker Zeitung*, 1923, page 146.

New Alloy for Grate Bars

THE burning out of grate bars, both in the industrial boiler as well as in the domestic steam heating furnace, is a rather common occurrence. In firing furnaces with mechanical stokers this has been a source of serious inconvenience. A new alloy, a special variety of cast iron, has been devised which appears to overcome most of the difficulties. The new alloy is a special form of purified cast iron with a much higher melting point and tensile strength. Its life is claimed to be from three to ten times that of ordinary cast iron and it pours without difficulty and does not crack. The cost is only 50 per cent higher than that of ordinary cast iron.—*Jour. Soc. Chem. Ind.*, 1923, page 375.

Paper from Banana Refuse

A GOOD paper can be made from banana refuse, according to the *World's Paper Trade Review*. The trash or refuse, consisting of the stems and leaves of banana trees from which the fruit has been cut, is passed through crushing rolls, which produces a mash in which the moisture has been reduced from 90 to 55-75 per cent. The liquid is drained off and the trash is passed through a breaking or pulping machine where it is reduced to a pulp. The pulp and juice from the machine are then placed in a boiler, water is added and the mixture is boiled at a pressure of four to five atmospheres for a period of three to six hours. The contents of the boiler are then transferred to a beater, where the resinous and gummy matters, which have been set free during the process of boiling, are washed away as powder or pellets by a current of water. The removal of the fibrous material from the beater completes the process, in which no chemical is used.

Sulfite Liquor for Building Purposes

ANOTHER use for the waste liquors recovered from sulfite cellulose mills has been developed as described in the German journal, *Chemiker Zeitung*, 1923, No. 23. Loam, as sandy as possible, is mixed with about 5 per cent of hydrated lime and about 2 per cent of the waste liquors is added. About 5 per cent of technical hydrochloric acid is added to the mixture. Other acids may be used as well. In this manner there is formed so large a quantity of hydrochloric-silicic acid that a solid, absolutely water-resistant stone is produced. When the process is altered in certain respects a product is obtained which may be used to good advantage as a substitute for tar roofing. This product is more lasting than the ordinary tar roofing and furthermore it does not possess the well-known advantages of the latter. By using this material the buildings may be finished off both inside and outside with the same building material and consequently the labor involved in using plaster and similar finishing materials is considerably reduced. Sulfite cellulose waste liquors can also be used to good advantage in manufacturing insulating sheets and plates, flower pots, as well as many articles made heretofore from hard rubber.

War Gases Cure Disease

THE Chemical Warfare Service of the United States Army has been conducting tests at the Edgewood Arsenal to determine the possibility of using war gases, originally intended to kill, to cure disease. The gases have been recommended as a cure for the diseases influenza, tuberculosis, paresis and other afflictions. Weak concentrations of chlorine gas introduced into the rooms occupied by those exposed have been asserted to prevent the spread of grip and influenza epidemics. Mustard gas has been demonstrated as a specific against tuberculosis. Tests have been made with guinea pigs inoculated with tuberculosis germs and a concentration of mustard gas, and it was found that the animals did not contract the disease. The substance lewisite was experimented with and it was found that this is a remedy if not a cure for paresis and locomotor ataxia. During the war the fact that chlorine could be used to prevent or cure colds, influenza or pneumonia was accidentally discovered at the Edgewood Arsenal. It was remarked that cases of pneumonia or influenza did not occur in the laboratory where chlorine was being made, although 10 to 20 per cent of others on duty at the arsenal were victims. Investigation showed that in the rooms where the chlorine gas was being made there was a slight leakage of chlorine, just enough to act as a germicidal agent.

Double Window Panes

DOUBLE window panes, separated by a distance of two millimeters and joined together by a specially designed and patented melting process, so that no moisture or dust can penetrate between them, are used to keep out the cold in the place of ordinary double windows, according to a Swedish process. The heat insulation is perfect under these conditions.

New Alloys

NEW alloys, which are especially well suited for making propeller shafts, are described in the German journal *Gewerbefleiss*, 1923, No. 3, page 84. These alloys are made by adding bronze or vanadium brass with copper, aluminum and nickel or with copper, aluminum and iron, or with copper, aluminum and manganese. Vanadium appears to combine more easily with iron, nickel or manganese than directly with copper or zinc, so that iron, nickel and manganese act as so-called intermediate media. Vanadium can also be added to the metallic composition in the form of ferro-vanadium. When this is done, the cost of the alloy is reduced.

Volomite, a Substitute for the Industrial Diamond

THE industrial diamond, the black bort, is replaced to good advantage by the cheaper volomite, according to a report of the Prussian Geological Institute. While the product volomite is not of maximum hardness, nevertheless it has been reported that it gives absolutely satisfactory results for boring rock of medium hardness. The reader is referred to the original article for further information.

Tallow Trees

IN Texas there is being grown a tree which is quite new to the United States. This is the Japanese tallow tree. Trees of this species bear nuts that contain a rich tallow-like oil. This oil has been found valuable in the manufacture of high-grade varnishes. It has been found that the climatic and soil conditions are well adapted to the growth of this tree in certain parts of Texas.

New Rust-Preventive Agent

ACCORDING to the *Umschau in Technik und Writschaft*, a part of the *Vossiche Zeitung*, February 23, 1923, a new rust-preventive agent or rather process has been developed which is particularly useful in protecting vehicles and vessels. The process consists in producing a coat of metallic cadmium on the metal. This film of cadmium has a thickness of from 0.002 to 0.001 of a millimeter and is produced in the electrical way by dipping the metal into a solution of a cadmium salt. The coated metal part is then placed in an annealing furnace, where it is heated to a glowing heat for a period of two to three hours and in this way the deposited film is made to alloy with the underlying metal. The surface coating that is produced in this manner is much more durable than the ordinary coatings produced by galvanizing with nickel, etc. The color of the treated part resembles that of a silver-plated article.

Blotting Paper from Wood Pulp

BLOTTING paper is generally made from rag pulp, and it is accordingly a really important achievement that has been recorded in the daily papers that a Canadian pulp mill has succeeded in manufacturing a very good grade of blotting paper from ordinary wood pulp. Blotting paper made in this manner costs considerably less than the other kind.

Differentiating Hemp from Flax

FLAX is one of those products that is subject to a great deal of adulteration, due to the fact that its supply is limited and its price is high. One of the substances used in adulterating flax is hemp, and this practice has been causing considerable trouble, due to the difficulty of differentiating between the two fibers. Cotton is also used to adulterate flax, but it is a comparatively easy matter to detect the presence of the cotton fiber mixed with the linen fiber under the microscope.

The Linen Research Institute of England has devised a simple test whereby it is a comparatively easy matter to distinguish between the linen and the hemp fiber. Considerable microscopic work was done and it was determined therefrom that the hemp fiber is developed on a right-handed spiral and the flax or linen fiber on a left-handed spiral. If a thread is frayed out and wetted it will tend to curl up either in the same direction as the hands of a clock if it is hemp, or against the clock if it is flax. If both motions are found in the same material, the so-called linen is bound to be a mixture.

Making Linen Bags More Durable

LINEN bags, especially those that are used for shipping fertilizers, are rendered more durable by dipping them into a solution of potassium silicate or sodium silicate (water glass). They are then wrung out well and dried. The solutions of the chemicals must be rather dilute. For further details, see the reports of the Academie d'Agriculture of Paris.

New Mercury Deposit

A NEW vein of quicksilver said to be seven miles long and to vary in width from two to six feet has been discovered near Kita Uonome in the Goto Archipelago. The ore contains 18 per cent mercury, and preliminary trials indicate that the vein increases in thickness with depth. This vein is important as none of the veins so far discovered in Japan are suitable for working.—*United States Commerce Reports*, Feb. 12, 1923.

Lignite Char

THE United States Bureau of Mines has made an exhaustive investigation into a process for utilizing lignite coal. As is well known, there are very large deposits of lignite coal in the states of North Dakota and Texas, as well as in Canada. These deposits are not being worked at the present time, but they represent potential sources of fuel which will sooner or later have to be resorted to as coal becomes scarcer. The Government has realized the possibilities of lignite coal, and experiments have been made to convert it into such form that it can be utilized as a general fuel.

The great trouble with lignite is that the coal contains a large amount of moisture and an appreciable amount of ash. The fusion temperature of the ash is comparatively low, which makes high rates of combustion difficult and requires larger grate areas and furnace volumes than with higher grade coals. In other words, the coal has to be improved first before it is possible to use it in the ordinary stove or furnace.

The lignite is accordingly charred. The moisture and volatile matter are driven off and a fuel is obtained which resembles anthracite coal except that it is softer and contains a little more volatile matter. This makes it easier to kindle. About 2.5 tons of raw lignite coal will produce one ton of char, which has a heating value of approximately 12,000 B.t.u.'s per pound. The moisture is very low, and the char can be stored without any danger of fire or degradation in size.

The Heavens in September, 1923

Some Details About the Total Solar Eclipse of the 10th

By Professor Henry Norris Russell, Ph. D.

ONE event, above all others, arrests the attention of the astronomical world, and of Americans in particular, this month—the total solar eclipse of the 10th. When the moon interposes herself between the earth and the sun, on this date, she is only 227,000 miles from us, while her shadow, tapering because the sun is larger than she, extends for a distance of 234,000 miles, reaching 7000 miles beyond the earth's center, and more than 10,000 miles beyond the earth's surface on the nearer side. At this distance from the point, the shadow cone is 90 miles in diameter. An observer on the moon, looking at the earth, would then see a small dark spot on it—hardly one-eightieth of the diameter of the disk—surrounded by a region where the sunlight was dimmed, but not wholly cut off. This spot would sweep eastward across the earth's disk at a speed equal to that of the moon's orbital motion—about 2200 miles per hour. But, as it moved, our imaginary Lunarian would see the earth rotating, carrying continents and oceans eastward at a speed of a thousand miles per hour on the equator, or from seven to eight hundred miles per hour in the latitude of the United States. The moon's shadow accordingly overtakes the American continent at the rate of some 1500 miles per hour, and takes three minutes and a half to move a distance equal to its own diameter. A point on the central line of the shadow track will therefore be in darkness for three minutes and a half, and one could go 20 miles or so on either side without finding the duration of totality much diminished. Since the sun's rays strike the earth's surface somewhat obliquely the full width of the shadow track is a little over a hundred miles. At the edge of this belt the sun will be hidden for but a moment, while points beyond will never quite lose the sunlight. For 2000 miles on each side of the central track, however, the moon will cut off more or less sunlight, and a partial eclipse, of greater or less magnitude, will be observable throughout the whole of North America.

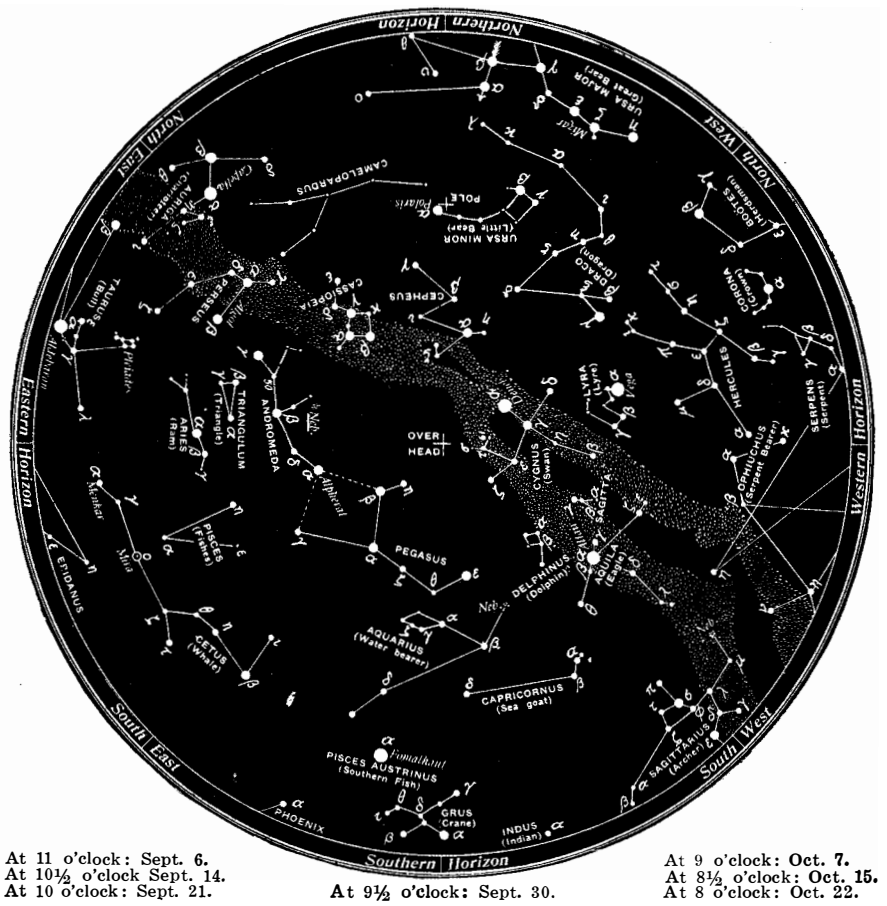
The shadow track, beginning in the ocean south of Kamschatka, sweeps over the Pacific, just missing the Aleutian Islands, and first reaches land in California. Curiously enough, the limit of totality just grazes the coast for nearly 200 miles. A few projecting points near Santa Barbara will be in darkness, but to get a reasonably long duration, observers will have to visit the islands offshore, or else go further south. San Diego enjoys nearly three minutes of darkness, but the central line comes ashore nearly 50 miles south of the Mexican boundary. Sweeping across Lower California and crossing to the mainland, the shadow traverses Mexico to Tampico, and later passes over Yucatan, to leave the earth at sunset on the Caribbean Sea, south of the Virgin Islands.

The Eclipse in the United States

Throughout the Pacific and southwestern States the partial eclipse will be a large one, three-quarters or more of the sun's diameter being hidden. Chicago will see the sun half hidden, and New York will have a somewhat smaller eclipse. The local time of the middle of the eclipse varies from shortly after noon (Pacific Time) at Seattle and 1 P. M. at San Diego to 3:30 (Central Time) at Chicago and 4:40 (Eastern Time) at New York—the differences arising mainly from differences in longitude. To these hours must still be added the change to Daylight Saving Time where this is kept.

The eclipse will be interesting to watch anywhere in America. But its main interest centers of course in the narrow zone of totality. The spectacle there will be fine enough, aside from its scientific interest, to repay any traveler for a long journey. The weird colors that bathe the landscape when only the light from the sun's edge remains; the advance of the moon's shadow, dark as the blackest storm, and traveling with the speed of a cannon ball; the sudden darkening of the whole landscape, almost as rapid at the last as a train entering a tunnel; the appearance of the stars, and of the corona encircling the eclipsed sun, and of the scarlet prominences, close to the moon's edge; and then the abrupt return of ordinary daylight and common life—all these combine into one of the most sublime of natural phenomena, memorable for a lifetime.

The sky around the eclipsed sun will be unusually starry. The sun himself is in the eastern part of Leo, about 15 degrees east of Regulus and 30 degrees west of Spica. More than this, Saturn is some 30 degrees east of the sun and close to Spica, with Jupiter some 20 degrees further on in the same direction, while Mercury is about half-way from the sun to Saturn. On the other side of the sun is Mars, about 60 degrees away, and Venus, by far the brightest of all, only 2 degrees from the sun. It is very unusual for all the brighter planets to be thus visible at once during an eclipse; and the long line of bright bodies, strung out on the ecliptic, will be a noteworthy sight.



At 11 o'clock: Sept. 6.
At 10½ o'clock Sept. 14.
At 10 o'clock: Sept. 21.
At 9½ o'clock: Sept. 30.
At 9 o'clock: Oct. 7.
At 8½ o'clock: Oct. 15.
At 8 o'clock: Oct. 22.

The hours given are in Standard Time. When local summer time is in effect, they must be made one hour later: 12 o'clock on September 6, etc.

NIGHT SKY: SEPTEMBER AND OCTOBER

The Astronomer and the Eclipse

The astronomer, of course, will go to *observe* the eclipse rather than to *see* it—and the man who gets 10 or 15 seconds to look at the sights will be lucky. A host of observations can be made, and most of them will be attempted by one or another of the parties. Photographs will be made of the corona and prominences, and of the stars around the sun, to get one more final confirmation of the "Einstein effect." The polarization of the coronal light will be investigated, and its heat measured. Perhaps the most important observations of all will be with the spectroscope—photographing the spectrum of the lower atmosphere of the sun, at the instant when the phosphorescence has just disappeared, or is at the point of appearance, and that of the corona during totality, to secure as much more information as possible about the enigmatical bright lines in its spectrum, which are still utterly uninterpreted.

The weather conditions—always the most vital consideration—are extremely favorable, cloudiness in the early afternoon at this season being very rare. The best prospects are on the Mexican border or just south of it. The islands off the coast have some risk—though a small one—of fog; the Mexican mainland, besides having poorer weather prospects, is difficult of access.

A party from the Lick Observatory will be at Ensenada, Lower California, where English and German parties will also be located. One from the Yerkes Observatory will occupy Catalina Island—one of the most easily accessible points near the central line. The Mount Wilson Observatory—which misses being in the zone of totality by less than 40 miles—will send two parties to San Diego; one to the shore, near the central line, the other on land, near the edge, where the flash spectrum will be visible longer. Spectroscopic observations of importance comparable to the others can probably be obtained with the great tower telescope on the mountain, where about 98 per cent of the sunlight will be cut off.

Lack of space forces us this month to omit the usual brief reference to the positions of the more prominent constellations. The map will have to stand on its own feet, without explanatory text.

The Planets

The remarkable display during the eclipse is necessarily matched by a corresponding dearth of planets in the nocturnal skies. Mercury is an evening star for most of the month, and may be fairly well seen about the time of his elongation, on the 2nd, when he is 27 degrees from the sun, and sets at 7:30 P. M.—though he is too far south of the sun to be conspicuous.

Venus is a morning start at the month's beginning, but passes through inferior conjunction on the 10th, only a few hours before the eclipse. She can hardly be seen under ordinary circumstances, for even at the end of the month she is but 6 degrees from the sun.

Mars is a morning star close to the sun on the 1st, but 16 degrees away on the 30th, and visible in the dawn.

Jupiter is still an evening star, and conspicuous, setting about 8:30 P. M. in the middle of the month. Saturn is an evening star also, but so much lower at sunset that he can hardly be seen.

Uranus alone is well placed for observation, being in opposition to the sun on the 9th. At that time he is in Aquarius, in R. A. 23 hours, 8 minutes, 6 seconds, and declination 6 degrees 27 minutes south; and is moving west 8.8 seconds and south 54 seconds per day. At the beginning of the month he is 15 minutes west and 8 minutes north of the fourth magnitude star Phi Aquarii, which may be found near the point where the western edge of the great square of Pegasus, carried southward, intersects a line joining Beta Ceti and Epsilon Pegasi. Only a large telescope will show his disk; but a field glass suffices to detect his motion among the stars.

Neptune, finally, is in Cancer, about 30 degrees west of the sun, and even the eclipse will not make him visible.

The moon is in her last quarter at 8 A. M. on the 3rd, new at 4 P. M. on the 10th—the time of the eclipse, of course—in her first quarter at 7 A. M. on the 17th, and full at 8 P. M. on the 24th. She is nearest the earth on the 12th and furthest away on the 28th. During the month she is in conjunction with Neptune on the 8th, Mars on the 9th, Venus on the 10th, Mercury and Saturn on the 12th, Jupiter on the 14th, and Uranus on the 23rd. Only the approach to Jupiter is observable, and this is far from close.

At 9 P. M. on the 23rd the sun crosses the celestial equator and enters the sign of Libra, and, as says the almanac: "Autumn commences."

The Motor-Driven Commercial Vehicle

Conducted by MAJOR VICTOR W. PAGE, M. S. A. E.

This department is devoted to the interests of present and prospective owners of motor trucks and delivery wagons. The editor will endeavor to answer any question relating to mechanical features, operation and management of commercial motor vehicles

A New Motor Pick-Up Street Sweeper

IN perfecting the present mechanically successful sweeper the engineers managed to surmount many obstacles, which formerly hampered economic operation. These mechanical difficulties common to this type of sweeping conveyor have not only been removed but a greater amount of working dependability has been incorporated.

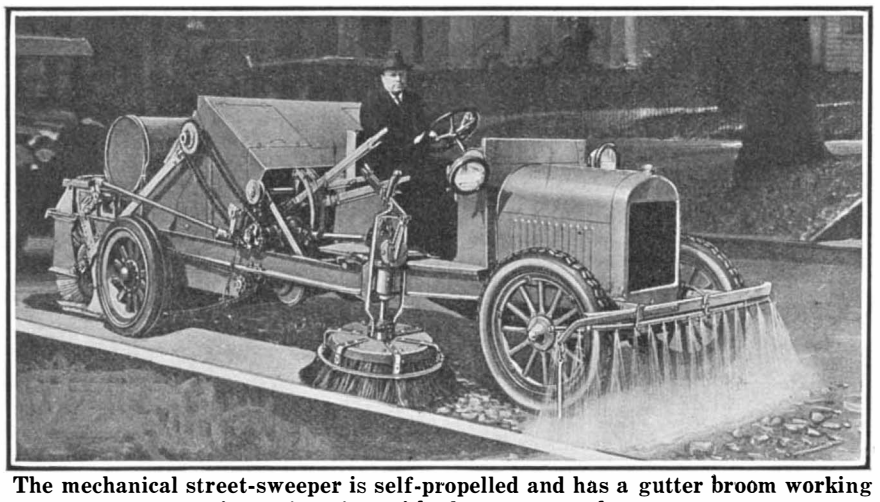
A noteworthy improvement in this sweeper is its automatic gutter broom that works in and out with the curb line, independently of the driver. The earlier types of sweeper did not have this provision for cleaning gutters with the result that additional men were required to complete regular cleaning equipment. Today with increased traffic pushing more refuse from the center of the street toward the gutters a greater need was created for a special attachment for cleaning the gutter. The gutter broom attachment was developed to take care of this need. It not only cleans the gutters more efficiently but with a great saving of labor cost as well.

The design of the large rear broom is such that wear automatically shortens the distance between the broom and conveyor. Fouling of the conveyor through breakage of the shear pins is prevented by the broom's coming to a complete stop. The conveyor is of large capacity and of the non-clogging type. Heavy sweepings are claimed not to choke the conveyor. The removable bottom, in itself a feature, is easily replaced. Only six drive chains are employed on the entire machine, including the conveyor. The sweeper can be operated while the machine is at a standstill. Mechanical parts are readily accessible. The working speed is nine miles per hour.

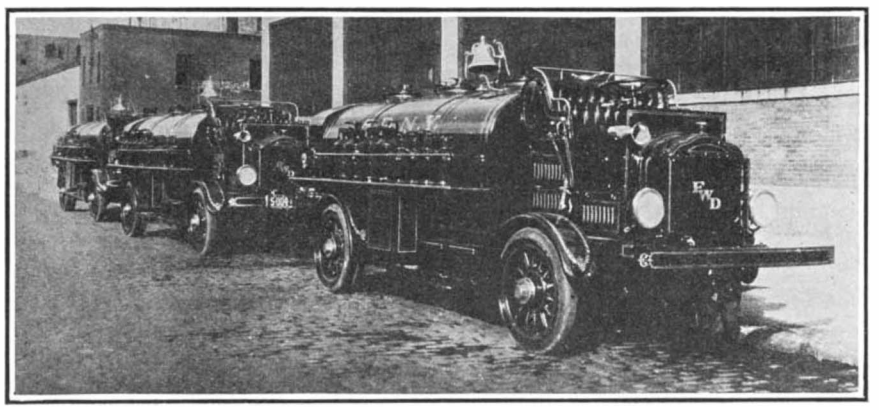
The new sweeper is of the four-wheel type and employs a speed-wagon power plant of standard construction with right-hand drive and self-starter. It is a one-man machine with all levers so arranged that the operator has complete and convenient control without leaving his seat. The rear axle of the speed-wagon is moved forward and converted into a jack shaft, whence the drive is through roller chains to each rear wheel. An auxiliary transmission is mounted between the transmission and differential to give power for operating conveyor, large broom, gutter broom and water pump. The large broom, of steel or bamboo, is driven by a roller chain on cut steel sprockets. This rear broom is quickly adjusted to the roads and is automatic in operation after adjustment, following the pavement with just enough pressure to do good work.

The conveyor is driven by roller chain on cut steel sprockets. The conveyor itself is of all-steel construction with removable bottom. Rubber squeegees mounted on extra carbon steel angles form the flights. An efficient anti-clogging device takes all undue strain off the conveying mechanism and allows piled material to be swept without clogging the conveyor. The hopper or dirt receptacle is also of all-steel construction. The gutter broom is driven through a universal joint assembly from auxiliary transmission. The broom is steel fiber filling, built up to 42 inches diameter in six segments that are easily and quickly changed when broom is worn out. The working range is seven inches.

The water sprinkling system consists of a 150-gallon galvanized iron tank with brass strainers at intake and outlet. Water runs by gravity to rotary gear Demming brass pump which forces water to brass nozzles mounted under the bumper in front. The water spray is controlled by the driver.



The mechanical street-sweeper is self-propelled and has a gutter broom working in conjunction with the pavement broom

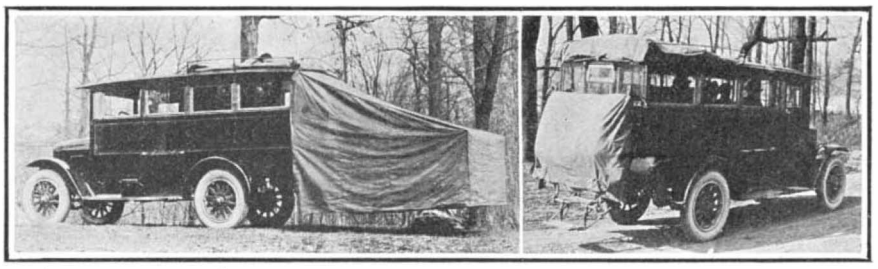


Gasoline supply motor trucks now being used by the New York Fire Department. These trucks are of the four-wheel drive type

New Supply Trucks for New York Fire Department

THREE new combination gasoline and oil supply tank trucks have recently been placed in service by the New York City Fire Department. These have four-wheel-drive chassis. They are the type having traction on all wheels, but steer only with the front wheels, and are the first of their kind to be purchased by the city of New York. These trucks are equipped with 900-gallon tanks with three compartments of 300 gallons capacity each. In addition, they carry four 5-gallon cans in the filler box, six 5-gallon safety cans and four 3-gallon oil cans with top stops—ample for the service they give.

It is intended that the trucks shall carry oil in one of the 300-gallon compartments and gasoline in the other two. They will be used to distribute fuel and lubricants to the various stations of the New York City Fire Department, supplying the needs for the operation of motor-driven apparatus, and should be of special value in the winter.



Motor truck touring home in camp for the night and on the road. Note the compact method of stowing the load

Motor Touring Home

ALL the thrills and benefits of a long automobile trip over mountain road or backwoods trail with the numerous comforts of home and no hotel expense may be provided by the latest motor vehicle, the motor-truck touring home. Where or how long, it matters not, for with the touring home distance and time and inconvenience are eliminated.

The touring home! What is it? It is the practical and efficient development of the dreams and ideas of thousands of tourists. In its design, the dominant idea has been to make it available to the average automobile tourist; in other words, to bring it down to what the engineers call a quantity-output basis in its manufacture. Real ingenuity has been exercised in making the equipment complete in its home appointments without being top heavy or cumbersome. Speed and flexibility of operation, moreover, are assured by the fact that the touring home is mounted on an International speed chassis.

Are the meals going to be properly cooked? How about the beds? What about rainy weather? These are questions that will at once occur to every practical-minded automobile tourist in contemplating the use of this equipment; but he needn't worry if he is going to hit the trail, this year, the "touring home" way. Every facility for properly cooked meals, real beds, just as comfortable and roomy as those at home, and complete protection against inclement weather are features that will make it a treat to travel in this latest type of home on wheels. Bodies of airplane plywood varying in length from 11 feet 8 inches to 19 feet 5 inches and in heights from 56 inches (standard) up to 76 inches with standard width of five feet are available. Two to four passengers can comfortably travel in the smaller and medium sizes and two to six in the larger vehicles.

"But how do we eat?" someone may impatiently ask at this point. Really, it's a simple matter. To the right in the rear is a kitchen cabinet; on top of this is a three-burner stove. Other cabinets contain provisions and tableware packed in such a way that there is no rattle.

"Where do we sleep?" is naturally the next question for the traveler to ask. It's an easy job to arrange sleeping quarters. First, the seats, which are collapsible, are put out of the way. Then the bed at the left side with full-size springs is let down and opened up the full width of the car. When not in use, this bed with pillows and blankets is protected by a canvas cover. Another bed with full size mattress may be let down at the rear and held two feet above the ground by means of chains hooked on to the top of the body. When not in use, this bed is fastened against the rear of the body and is covered by a dust and waterproof canvas.

The bed in the rear is completely covered and curtained by a double tent carried on the top of the body, which in the daytime may be used as a protection from the sun when passengers wish to eat outside. Flexible windows are provided in these curtains. When it is desired to eat outside, the cabinet doors which form the table inside can be removed, fitted together, and mounted on collapsible legs.

There are boxes for camping tools—all the tools are provided—convenient racks for clothing, a canvas water bottle which keeps the water cool by evaporation, toilet facilities, electric lights; in fact, everything one has in the home. Everything is packed conveniently in small space, and everything one could desire is in its place. In a few minutes, one can make camp or be on the road to the next stop miles away—wherever and whenever the whims of the party decide. The enthusiastic motor traveler, in truth, can go as far as he likes and come back whenever he pleases in this flexible, convenient touring home.

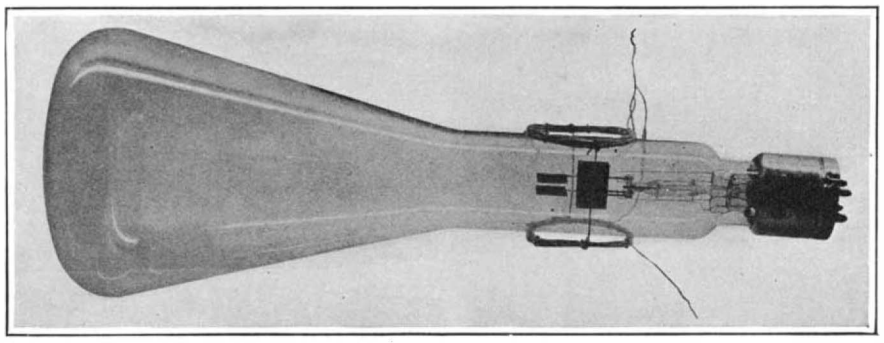
The Cathode-Ray Oscillograph

Measuring Electric or Magnetic Forces by Their Effect Upon a Stream of Electrons

By J. B. Johnson

Of the Bell System Research Laboratories, Western Electric Co.

IF THE stream of bullets from a machine gun pass through a stiff squall of wind, they will strike the target at one side of the bull's eye, and this deflection will be a measure of the force of the wind. In much the same way the stream of tiny electrons shot from the hot filament of a vacuum tube can be deflected by electric or magnetic forces, and if a target is put at the end of the tube, the amount of the force can be measured from the deflection it produces.



Over-all view of the tube used in the cathode-ray oscillograph

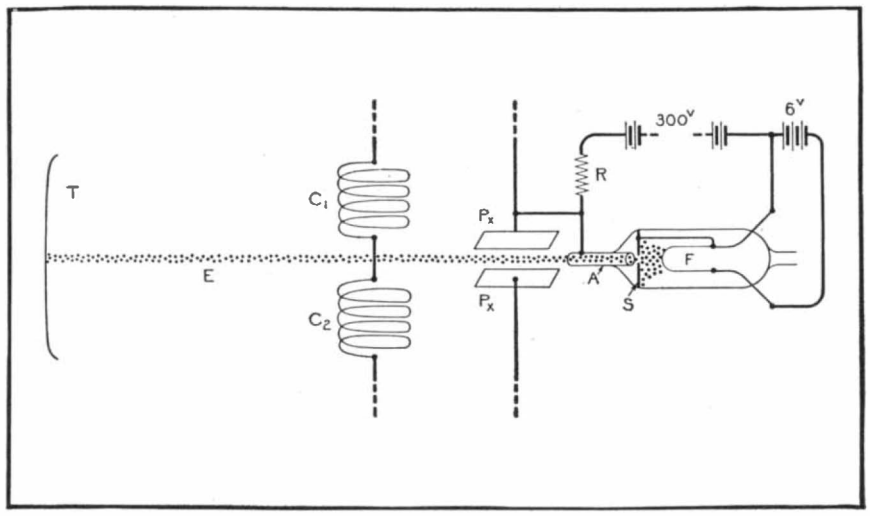
This in brief is the fundamental principle of the cathode-ray oscillograph, invented about 25 years ago by Braun, and known by his name. In Braun's tube the electrons were started by a high voltage between the metal terminals which were sealed into the glass tube, which was then exhausted of nearly all the air. Some of the electrons went through the hole in the plate in a tiny stream, which struck the target. This plate was coated with substances which glowed when struck by the electrons, so that a spot of light indicated the end of the stream. If an electric voltage was applied between the plates, the stream would be deflected toward the positive plate, and the spot would move across the screen.

The Braun tube had two limitations—the air left in it was gradually used up and had to be renewed, and the voltage required was from 10,000 to 50,000 volts direct current. This was not only expensive and hard to handle, but dangerous to the operator. Hence the Braun tube never was used as much as its other good points deserved.

With the development of the modern vacuum tube, however, a way was opened to get the desired stream of electrons more easily since electrons are given off a heated filament at moderate voltages. In the drawing, *F* is the filament, heated by a six-volt battery. Another battery, usually of small dry cells like the familiar radio "B" batteries, provides 300 volts between the filament and the other electrode *A*. This voltage draws off negatively-charged electrons from the filament, which pass through the little hole in the plate *S*. The electrode *A* is in the form of a little tube, down which the electrons pass. From its end they shoot off between the pair of plates *Px*, and down the vacuum space until they strike the target *T*. (For simplicity only one of the two pairs of plates shown in the photographs is mentioned here. The second pair is at right angles to the first, and is used to move the beam at right angles to the motion produced by the first pair of plates.) One plate of the pair *Px* has a lead which comes through the glass to a terminal and the other plate is connected to the electrode *A* and so to a terminal outside the tube. Thus a voltage can be put across the two plates *Px* and the stream of negative electrons will be drawn toward whichever plate is positive. The movement of the spot of light which shows the end of the stream on the target is then a measure of the force exerted on the stream at the plates, and so of the voltage applied to them. Since the stream of electrons has practically no weight, a change in the applied voltage is registered instantly in a movement of the spot. This instantaneous feature is what makes the device so useful, because the spot will faithfully follow alternations of the voltage up to a million cycles per second, or even more.

When the thing to be measured is a current rather than a voltage, two small coils of a few turns of wire are placed on opposite sides of the tube. The magnetic effect of the current will deflect the stream in a direction parallel to the plane of the coils, and the luminous spot will move just as before.

In the development of this device, one difficulty was overcome in a way which gives an interesting illustration of what happens when electricity flows through a near-vacuum. The stream of electrons which shoots out from the tube *A* is not like a stream of machine gun bullets, each of which flies independently of all the others. It resembles more a stream of water from a nozzle, the individual droplets of which tend to fly apart. The repulsion between electrons makes the stream spread out so that it will not give a sharp spot on the target. The remedy was developed by our engineers, who during their experiments made up a tube containing a small amount of gas. Now every gas is made up of separate molecules, each of which has a comparatively large central nucleus, positively charged with electricity, and surrounded with a number of negatively charged electrons held to it by electric attraction. The free electrons shoot down the tube at a velocity of about 6000 miles per second, and when one of them hits one of these molecules, the force of the collision knocks off one or more electrons from the molecule. Formerly the positive charge of the nucleus was neutralized by its ring of negative electrons, but when some of the electrons are knocked off, the nucleus, now positive, begins to attract the free negative electrons. Since these nuclei are heavy and sluggish as compared to the flying electrons, they are simply buffeted around by the latter, and they stay for a time in the line of the electron stream where they were formed. Thus there is along the whole length of the stream a line of positive nuclei which attract the free electrons and hold them in the straight path, in spite of the repulsion between electrons which tempts them to spread out. Further, the dislodged electrons shooting off in all directions soon fill the space outside the stream with negative charges, which repel the flying electrons and make them keep in their own path.

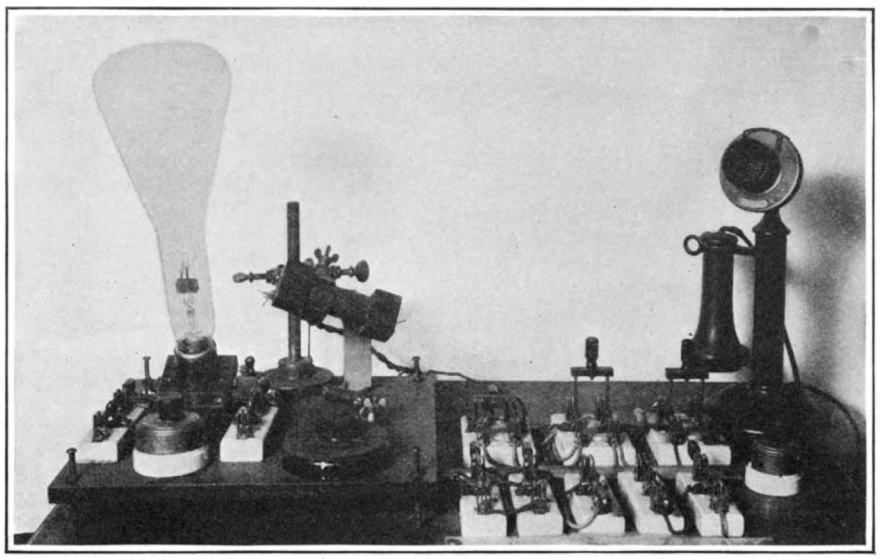


The electrical principles involved; for references, see the fourth paragraph of the text

The usefulness of this tube oscillograph comes from the fact that the stream of electrons forms a nearly weightless pointer whose movement will accurately follow the changing conditions in the circuit to which it is connected. In order to be able to follow the magnitude of separate swings it is necessary to draw the beam back and forth across the target so that the path of the spot during consecutive swings will not overlap. Up to a few hundred cycles per second, this can be done by waving a bar magnet back and forth near the tube. Since the electron stream is really a current of electricity, it is deflected by a magnetic field just like a wire carrying a current. If it is necessary to repeat the pattern, the side-to-side motion can be made uniform by rotating near the tube a coil carrying a constant current.

In most cases, however, what is wanted is the variation of a high-frequency current not with time, but as some other quantity is varied. For instance in radiotelephony it is often desired to know the variation of the radio-frequency modulated current with the voice-frequency input to the modulating tube. This relation is of utmost importance as it indicates whether the outgoing waves will set up an undistorted copy of the original speech when they reach the receiving stations. In this case the circuits are so connected to the two sets of deflector plates that while the radio output moves the spot up and down, the audio input moves it sideways. According to the theory of modulation, the amount of radio current should vary uniformly from zero to a maximum as the voice current moves from one extreme of its cycle to the other.

The chief value of this cathode-ray oscillograph is to get quick visible indications of what is going on in an electric circuit. Thus it can be used rather to explore a situation and find out roughly what is going on, as a first step to devising measurements which will be more accurate. For example, after the apparatus is set up, hysteresis loops can be taken very rapidly on one sample after another, as against half a day each by the more accurate "point-by-point" method. Also for demonstrations before classes up to about 20 persons, this device shows what is happening with a clearness that is most convincing.



The cathode-ray oscillograph set up in the laboratory, ready for use

The Most Famous Taxi in the World

TAXICAB 2862 G-7 will never wear out nor suffer a collision, for it has been selected to represent the "taxis" of the Marne" and has been placed in a position of honor in the Invalides. The ceremonies of installation were most impressive, but the shining cabs failed for the time to cruise for fares, for they were wanted "in formation" at the great parade ground.

Recently Patented Inventions

Brief Descriptions of Newly Invented Mechanical and Electrical Devices, Tools, Farm Implements, Etc.

Chemical Processes

AROMATIC HYDROCARBON CEMENT.—W. S. BARRIE and L. CHADWICK, Selwyn, via Townsville, Queensland, Australia. This aromatic cement, which may be used for building purposes in general, is a chemically prepared compound as follows: Pitch, tar or any other substance which consists principally of aromatic hydrocarbonaceous matter of an aggregate specific gravity of not less than one decimal one is first brought to a temperature of 120 degrees Centigrade to 180 degrees Centigrade, to this when thoroughly heated is added in powdered form a sulfate salt while the tarry material is in a fluent condition.

METHOD AND APPARATUS FOR PRODUCING A CHEMICAL UNION BETWEEN HYDRO-CARBON GASES AND HYDRO-CARBON OILS.—H. B. SNYDER, Box 43, Bridgetown, Texas. The object of this invention is to provide an apparatus by which a complete union between natural or methane gases, CH_4, and heavy hydrocarbons, such as C_{15} H_{32}, may be had, and thereby producing hydro-carbon compounds, such as C_8 H_{18}, or other hydro-carbon compounds. The method consists in subjecting a volume of methane gas to a high degree of compression, then introducing a quantity of hydro-carbon oil, and passing an electrical arc through the gas and oil while in its compressed state.

PROCESS OF TREATING VEGETABLE FIBER.—H. C. FUELLER, 2001 Chateau St., N. S., Pittsburgh, Pa. The invention has for its object to provide a process for preparing Florida or Spanish moss for use as a stuffing for mattresses and the like. The process consists in the chemical removal of the plant juices from the fiber, the dyeing of the fiber, and its treatment for stiffening and glossing the same, the removal of the plant juices consisting in subjecting the fiber to acid and alkaline baths.

Electrical Devices

SWITCH.—G. C. WERNER, 18 Logan St., Brooklyn, N. Y. The invention contemplates for one of its principal objects the provision of a double switch provided with means which render the same capable of either mechanical or electrical actuation. A further object is to provide a switch which is simple in construction and method of operation, durable, inexpensive to manufacture and highly efficient.

FUSE PLUG.—W. P. BRIGGS, 212 Mieope Bldg., New Bedford, Mass. An object of the invention is to provide a construction wherein only the proper size plug may be used in any given cut-out. Another object is to provide a fuse plug using prongs, instead of a threaded sleeve, and to provide a construction of plug and socket, which will not only require the proper size fuse and plug, but will indicate the size to be used.

CEILING FAN.—M. M. GLASSER, 42 Lawrens St., Charleston, S. C. The invention relates to motor operated fans, and particularly, although not necessarily, to ceiling fans, the purpose being the provision of a ceiling fan which provides simple and efficient means for effecting the bodily oscillation of the fan wheel whereby the air current produced by the fan is continuously diffused over a constantly changing area.

Of Interest to Farmers

BEET HARVESTER.—L. V. CIRAC, Box 4, Fallon, Nevada. Among the objects of the invention are to provide a beet harvester that will top the beets before lifting them out of the ground, the device having a vertically adjustable topper and frame, an adjustable width of track so that it may be adjusted to the width of row, and may at the same time be used in connection with cultivating tools, such as weeders, shovel plows, etc.

CROP DUSTING MACHINE.—C. G. ALLGRUNN, Niagara Sprayer Co., Middleport, N. Y. The invention more particularly relates to a feeding hopper for dusting machines for applying chemicals in powdered form to growing plants. Among the objects is to provide a hopper for carrying the chemicals, and to provide agitating mechanism within the hopper which may be adjusted in such manner as to vary the quantity of chemical discharged over a given area.

TRACTOR CULTIVATOR.—C. E. DOWNIE and G. D. GRAVELY, Portsmouth, Va. The object of this invention is to provide a tractor cultivator having a capacity for carrying out the various earth working operations, and adapted to be conveniently controlled by a single operator. A further object is to provide a tractor cultivator including a single traction wheel, and driven from a power plant comprising a pair of cylinders so organized as to be susceptible of driving the same through a positive train of gearing, thereby eliminating the necessity of employing universal joints.

COTTON HARVESTER AND CONVEYER.—D. DANIEL, 412 E. Markham St., Little Rock, Ark. The object of the invention is to provide a cotton harvester and conveyer of extremely simple and durable construction, reliable and effective in operation, to perform a maximum amount of work at a minimum expense. The apparatus combines a wagon, a fan exhaust and suction header, a flexible pipe and harness to facilitate the carrying of the same by the picker.

PITCHFORK.—E. LUUKKONEN'S, c/o T. Kronbolk, Milford, Utah. The invention relates to a pitchfork wherein any of the tines may be removed and replaced at any time, the crossbar being provided with a plurality of sockets, the tines having their upper ends shaped to fit the sockets, and a pin extending through the shank for locking the shank and tine in place. In this way the breaking of a tine is not a great misfortune as repairs can easily be made. (See Fig. 1.)

ATTACHMENT FOR GRADERS.—A. CIMFL, Rice Lake, Wis. The invention refers more particularly to a supporting shoe adapted for connection with a road grading or scraping machine for the purpose of bridging wash-outs or depressions in the side of the road to prevent the rear outer supporting wheel and the blade from dropping down and cutting the depression deeper. The attachment is provided with means for adjustment and is operable by the operator of the machine.

GRASS-DIGGING IMPLEMENT.—W. L. Foss, Box 15, Windom, Minn. The invention relates to an implement for removing quack grass. An object is to provide of this character of simple and efficient construction which when drawn over a field automatically effects the complete removal of this grass from the soil. The device includes digging units for loosening the soil, and ejecting units for removing the roots.

Of General Interest

FOUNTAIN PEN.—D. LA R. EASTMAN, 304 Waverly Ave., Syracuse, N. Y. This invention has for its object to provide a self-filling pen which comprises a minimum number of parts, yet will hold a relatively large amount of ink. A further object is to provide a form cylindrical-plunger to act as a self-filling device. When the ink runs low the plunger and sleeve are forced downward, the pen is inserted in an ink container and the plunger and sleeve are pulled back toward their normal position, sucking ink into the barrel. (See Fig. 2.)

SUBSURFACE FISH BAIT.—W. E. KOCH, Rutland, Vt. Among the objects of the invention is to provide a lure which when used in trolling will give the bait the appearance of a live fish, the bait being of such a shape as to automatically move back and forth and pull through the water in a given direction, the parts being so formed that the lure will turn on its side and zigzag continuously.

MEANS FOR MOTHPROOFING FURNITURE.—I. J. WEINBERG, 3318 W. Madison St., Chicago, Ill. The principal object of the invention is to provide a means for mothproofing furniture which may be disposed along the seams of the furniture, thereby effectively protecting the entire article, as it is at the seams that the moth usually commences work. A further object is to provide a device which may be disposed in any seam of the furniture, and secured as the latter is being manufactured, without changing the furniture in the slightest degree. (See Fig. 3.)

ADJUSTABLE TRACK.—H. C. KOLLING and W. MCGILL, 1147 S. Wichita St., Wichita, Kansas. The invention more particularly relates to tracks which are adapted to be placed upon a series of steps, such as those leading to a dwelling, to provide a plain surface over which rollingly supported articles such as a baby carriage, or furniture, may be easily moved without being subjected to shocks and jars.

MARINE PROPELLER.—G. W. LAWSON, 953 52nd St., Bayridge, Brooklyn, N. Y. The invention aims to provide a construction which will increase the power of any propeller of a given size with a minimum expenditure of energy. One of the main features resides in forming the blades with a working face of substantially the same width throughout the base. A further object is to construct a propeller in which the leading edge of the blade extends in advance of the forward end of the hub to obtain an initial purchase on the water forward of the hub to avoid suction.

COLLAPSIBLE CORE.—J. F. WALLACE, c/o Dept. of Water and Supply, Room 2344, Municipal Bldg., New York, N. Y. The invention relates to cores used in forming concrete tubes on conduits. An object is to provide a collapsible core so formed as to be built into a nested formation for making a plurality of openings in concrete castings for the use of electric wires or other similar use. A further object is to provide a core with hinged parts so formed as to be readily constricted for permitting removal whenever desired.

FOUNTAIN PEN FILLER.—P. S. HAUTON, 30 Church St., New York, N. Y. The invention has for an object the provision of means wherein a substantially full supply of ink is drawn in upon each filling operation. A further object is to provide a filler having a collapsing mechanism for the ink sack and means co-acting with a threaded cap which will permit the cap to have a dead motion for part of the time during its operation in order to give the bag time to distend and draw in the ink.

SAFETY RAZOR.—J. J. SHORT, 112 W. 63rd St., New York, N. Y. Among the objects of the invention is to provide a simple form of safety razor wherein the blade may be readily inserted and removed and when in place is rigidly clamped against accidental movement, and wherein an arc-shaped edge is presented with guarding members so positioned as to prevent accidental cutting of the face.

ARTICLE OF FURNITURE.—P. CAMINONI, JR., 12 E. 15th St., New York, N. Y. The invention relates to collapsible furniture of a readily portable type. The particular object is to provide a structure which may be provided with members of collapsible vertical walls, such as two walls to make a corner cabinet, or three or more walls to make a cabinet of different sizes to be placed anywhere in a room.

ENVELOPE.—STELLA BENENATO, 221 E. Polk St., Phoenix, Ariz. This invention relates to a means for connecting a series of envelopes, cards or other mailable matter. The object is to provide means whereby the operator of a typewriter may quickly address a large quantity of envelopes by reason of the fact that they are constantly in receiving position. The envelopes are adjusted to permit of single, double or triple spacing. The hinge-like connections may easily be removed after the envelopes are addressed. The flaps may be damped and sealed without individual pick-ups, thus a great saving of time, practically 198 arm movements to each hundred envelopes. (See Fig. 4.)

PHONOGRAPH RECORD.—W. C. HADLEY, c/o Munn, Anderson & Munn, Woolworth Bldg., Broadway, New York, N. Y. The object of this invention is to provide a phonograph record which may be used on any of the well-known phonograph machines provided with an automatic stop, so constructed that it may be possible to accurately set the stop mechanism to be operated at a definite point, and having been set, it may be permanently locked and operated with any

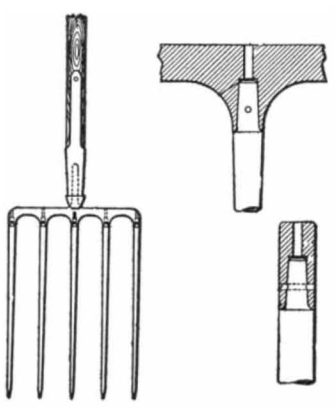


Fig. 1. Broken tines can be replaced in E. Luukkonen's pitchfork, just patented

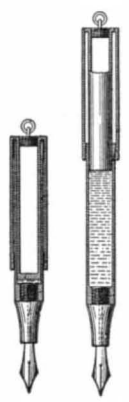


Fig. 2. New type of self-filling fountain pen, invented by D. La R. Eastman

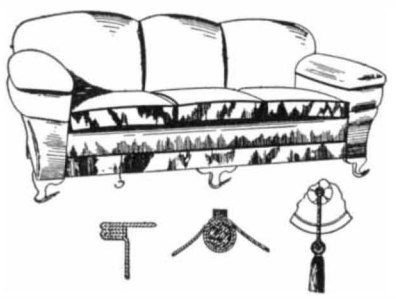


Fig. 3. I. J. Weinberg's device for rendering upholstered furniture moth-proof

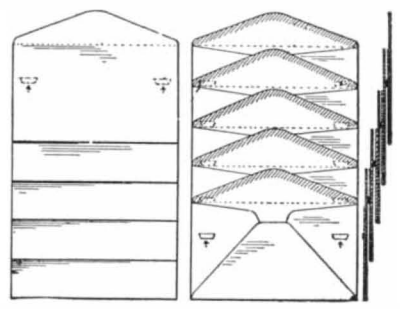


Fig. 4. Envelope assembly for facilitating addressing on the typewriter, patented by S. Benenato

Electrical Notes

Summaries and Excerpts from Current Periodicals

An Electric Locomotive, the first of a number to be supplied to the York and Northeastern Railway, is called the "Flying Scotsman." It will haul a load of 450 tons at a mile a minute.

The Electric Steam Generator is a recent product of the General Electric Research Laboratories. A cylindrical tank has a hot well below and electrode chamber above. Water is fed into the hot well and converted into steam in the upper chamber by the passage of current through the water. The purpose is to furnish steam for heating purposes at times when for one cause or another the regular heating is not economical, such as over weekends and during late spring cool waves.

Bare Aluminum Conductors. — While aluminum has been employed for some time back in high-voltage transmission line work, its use as a material for heavy current bus bars or for other bare station conductors is still to be established. Recent experiences in England seem to indicate that for such purposes aluminum can be used instead of copper with a considerable saving. In addition, the weight to be supported by the insulators would be halved by such a substitution, and other advantages are gained in the matter of more ready installation and better cooling.

Eight-Hour Recharging of Storage Batteries is the main feature of a motor-generator recharging unit recently placed on the market for the use of battery recharging stations. The new unit charges batteries with current having voltage that harmonizes with voltage of battery. It handles each battery as an individual unit and will not damage a battery by excess flow of current. It recharges a battery in one-fourth the time required by other methods. It will not overcharge a battery, or cause excessive gassing. There is no waste of current in this system of charging, for the battery takes its full charge and then "floats" on the line.

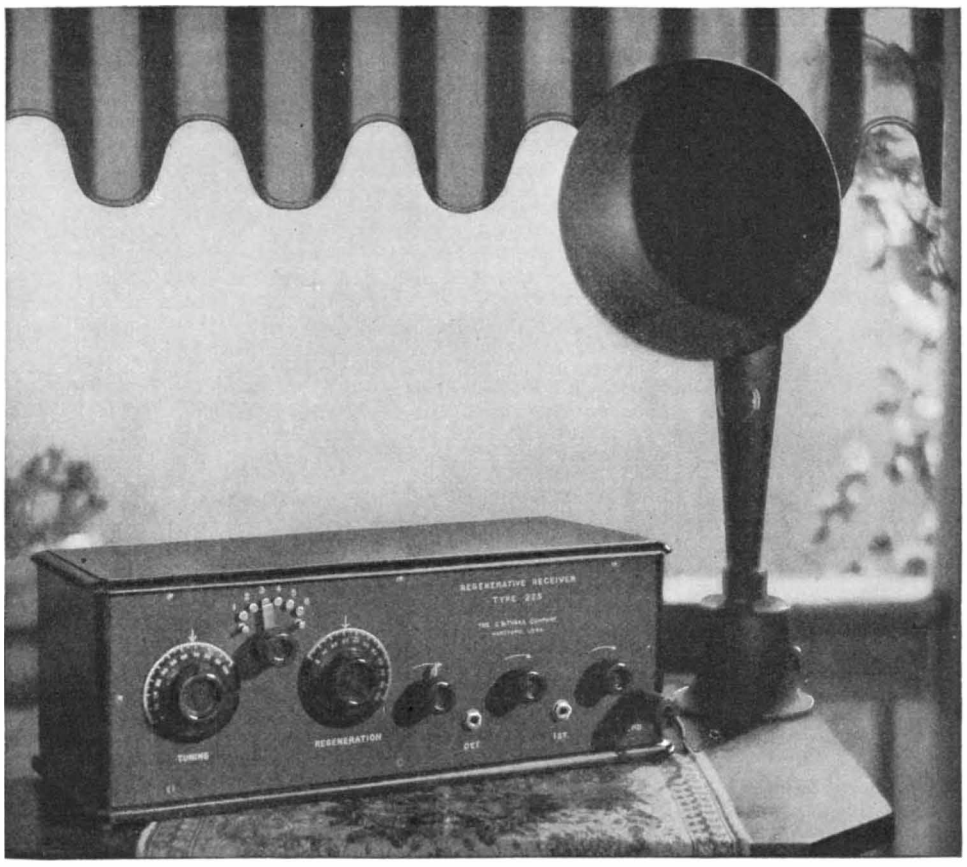
Large Turbo-Generators and Cheap Power.—Not many years have passed since the largest power plant in this country the Interboro plant in New York, represented the last word in power plant design, with its eight enormous engine-driven units of 7500-kilowatt maximum capacity each. Stations today are designed for five or six times that capacity. Their first cost, continues *The Electric Journal*, has been reduced inherently from one-third to one-half; their efficiency has been improved some 40 per cent. A pound of coal yields to the electric light user over five times the illumination that it did 20 years ago. Turbines like those installed in the Hell Gate power plant in New York—the last word in power plants—will develop a kilowatt-hour on about a pound and a half of coal. The Interboro plant took two and a half pounds. This improvement in station efficiency, accomplished within two decades, would mean a coal saving on a 300,000-kilowatt plant of something like 600,000 tons of coal a year.

In Making an Electric Weld in commercial cast iron, says *The Engineer*, the surfaces which are to be joined must, of course, be melted. When these surfaces, which consist of iron containing carbon in both the free and the combined states, are melted, several things happen. First, all the carbon goes into solution in the molten metal. Second, some of the carbon, silicon, and manganese is burned out by the heat, while the sulfur and phosphorous are practically unaffected. The tendency, therefore, is to produce a cast iron in the weld that will be white when cold owing to its low content of silicon and carbon. Third, the surface of the molten metal oxidizes, making a slag, which partly prevents further oxidation. As soon as the welding heat is removed, the melted iron hardens very quickly, giving up its heat to the neighboring cold metal and to the air. The sudden cooling produces a chilled hard white metal in the weld, the hardness being due to the fact that much of the carbon remains in solution if the cooling is sudden. Of course, if the casting has been preheated before welding, the cooling of the added metal will not be so sudden, and a softer machinable weld may be secured.

A New Electric Condenser which has appeared in Europe is constituted by plates or ribbons of a special quality of celluloid, called cellon, upon both sides of which silver armatures are deposited by a chemical process. The cellon employed can stand 40,000 volts per millimeter and has a specific inductive capacity of four. The dielectric losses are very low, of the order of one per cent at 50 cycles. The losses at the edges are reduced to a very low value by surrounding the armature edges by an extremely thin, high resistant, border of alloy. In the case of a battery for power-factor improvement, the edge losses are reduced to 0.1 or to 0.2 per cent of the apparent power. The condenser, continues *Elettrotecnica*, takes the form of a porcelain cylinder closed by metallic caps, so that a number of cylinders can be connected in series by simply superimposing them. Applications of the new condenser are considered. The claim is made that when it is used as a "passing-through" insulator for high pressures, it allows a very efficient and reliable apparatus to be obtained. It is also remarked that, owing to the perfect adherence of the armatures to the dielectric, very silent working is obtained by the use of this condenser in radiotelephony.

Melting Brass by Electricity. — The theoretical advantages gained by melting brass in electrical furnaces have been summarized as follows: (1) Melting may take place in a neutral or reducing atmosphere, thus minimizing loss of metal by oxidation and improving the quality of the product through freedom from oxides. (2) Metal of crucible quality may be obtained without the use of crucibles. (3) Melting may take place in a tightly closed chamber, or at least in one free from the constant passage of the products of combustion of fuel, and thus losses of volatile metals, such as zinc and lead, may be reduced. Contamination by sulfur from fuel is avoided. (4) In some types of electric furnaces the temperature may be more readily controlled than in fuel-fired furnaces. (5) In some types of furnaces the molten metal is thoroughly stirred, thus giving a uniform product, even with large heats. (6) There is no handling or storage of fuel, such as coke, coal or oil, and no ashes have to be removed. The cost of power can be accurately predicted over longer periods than the cost of fuel. (7) Working conditions about the furnaces are less dangerous to health and safety of workmen, provided suitable types of furnaces are chosen. (8) The above advantages may be obtained in furnaces of larger capacity than can be used satisfactorily in the fuel-fired crucible types, with resulting greater uniformity of product, lower labor cost, and increased production.

Magnetic Separators to Recover Unburnt Fuel from Ashes.—The German firm of Fried Krupp have devised a magnetic separator for the purpose of recovering coke and unburnt coal from ashes, according to *Engineering*. Practically all coals contain iron in the form of pyrites, which has no magnetic properties. The burning of the coal, however, converts the pyrites into oxides, which are magnetic; and as the whole of the iron passes away with the slag, the metal exists there in a very much more concentrated form than in the original coal. These facts are taken advantage of to effect the separation. The machine employed consists essentially of a magnetic drum over which the furnace refuse is passed. The drum rotates slowly about a horizontal axis, just as in the case of an ordinary magnetic separator. The ashes to be treated are delivered by a bucket-elevator to a vibrating screen which separates them into various sizes. Each size is passed separately on to the circumference of the drum. The slags containing iron are held magnetically to the surface for a portion of the revolution, and then drop off into small wagons or other receptacles as the current exciting the portion of the drum which held them is automatically broken. The coal and coke which may be present do not adhere to the drum but leave its surface directly after contact with it and fall into their own receptacles. It is said that lumps of slag up to 3-inch mesh will adhere to the drum and thus be eliminated from the fuel.



The New Tuska Popular No. 225

Regenerative Receiving Set, $75 without tubes, batteries, or loud speaker. Licensed under Armstrong Patent No. 1,113,149.

Special circular 20-A sent on request.

Like a good old reliable friend

YOU turn to your Tuska radio set with perfect faith that it is always ready to be called upon. There is no fussing or coaxing—no apologies for its shortcomings. Year after year you can count upon this reliability of performance. New models will come, as in pianos and fine motor cars. But few will discard the old and buy the new for the sake of minor refinements. The Tuska set represents the highest point in radio development to-day; you can buy it for the future with confidence.

The Tuska is the ideal set for busy people who want the thrills of radio without the tinkering. It is simple to operate. You turn two dials, listen, and select the exact program you want from the dozens which fill the air. Nothing is forced upon you by the limitations of your set—every broadcasting station within hundreds of miles is within the call of your Tuska. A letter from Prince Albert, Saskatchewan, Canada, says, "We have tuned in clearly over 100 stations and most of them are more than 1000 miles away."

Tuska sets are built under the personal direction of C. D. Tuska, a nationally known radio pioneer and builder of fine apparatus. For a dozen years Mr. Tuska has been keenly critical of all radio parts and sets bearing his name. As a result, the Tuska seal is recognized as a guarantee of the most thorough New England craftsmanship—and there is no better.

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TUSKA RADIO

Miscellaneous Notes

Odd and Interesting Items from All Sorts of Sources

Selling Bells by Phone.—Listening by long distance telephone from Boston to the tolling of several bells at Troy, N. Y., enabled a church committee deputed to purchase a bell to make a decision without the expense of a trip to the factory.

Americans to Print Works for Blind.—William Nelson Cromwell, President of the American Committee in Aid of the War Blinded, has bought the mansion of the Duke of Clermont-Tonnerre in the Rue de Lauriston, Paris. Here will be installed the greatest Braille printing works on the continent for the free distribution of printed matter to the blind.

European Daylight Muddle.—Tourists are going to be bedevilled all summer with the vagaries of European time. Summertime began in England on April 22, in Belgium on April 21, Holland, Germany and Spain were undecided and France has decided against it, so the railroad authorities are in a terrible muddle. France now has Strasbourg time half an hour in advance of Greenwich Standard.

New Way to Cut Conch Shells.—A successful mechanical process for cutting conch shell has just been invented in India, according to Vice Consul Harold Shantz, Calcutta. The new invention consists of an elastic composition grinding disk, which cuts through the shell in a manner much more satisfactory than any of the high-speed disks of various metals tried before. This invention is of considerable importance because the shell, apart from its sacred significance, forms the basis of a large and profitable industry in many centers of India, where it is cut into rings, bracelets and other shapes.

Armor for Police.—The war resulted in a reversion to the armor of mediaeval and post-mediaeval times, and if it had continued for any longer period the developments along this line would have been still more pronounced. The so-called "siege police" in Paris have been equipped with a new armor which greatly resembles the old models. A steel breastplate is made of laminated steel attached to which there is an "apron effect" reaching to the thighs. The head is protected by a helmet perforated with peepholes. The armor has successfully withstood revolver bullets at a distance of 35 feet, which is fairly near for riot duty.

Turning Out Letter Boxes in Naval Gun Factory.—In line with the Administration's program of rigid economy in all governmental expenses and as an echo of the armament conference, the big naval gun factory of the Washington Navy Yard has been converted in part into a letter box manufactory. This is the first time in the history of the department that it has been independent of outside manufacturers. Under the agreement with the Navy Department the boxes of steel, brass and zinc are obtained at the actual cost of making, and at the same time work is provided for employes who otherwise would be out of jobs.

Newfoundland Iron Mines Closed.—Work has recently been suspended indefinitely at the iron mines on Bell Island, in Conception Bay, Newfoundland, and about 1600 men have been dropped. Apparently there is no present market for the ore. The last shipment of 6500 tons left the island on January 12 for Germany, completing an output of 750,000 tons, or 100,000 tons more than the contract called for. Previous to the war the average annual shipments of iron ore from Bell Island to the United States amounted to about 300,000 tons, most of which went to Philadelphia, but now there are no shipments.

Thermit Welds by Lighthouse Service Employes.—Repairs to York Spit Light Station, Va., on account of damage by collision, were recently completed. These included a thermit-weld repair of a broken casting of one of the bearing piles of the structure. This was accomplished successfully and without employment of specialists. When the lighthouse tender arrived work was immediately started, making the mold box and preparing the mold. Twelve hours actual labor was consumed in the work. It was necessary to work continuously after arriving at the station, as it was inadvisable to make the mold and allow it to stand on account of the danger of the heavy seas wetting the materials in the mold, which would have necessitated repeating the entire process.

Orange Exporting Countries.—Spain, Italy and the United States are the heaviest exporters of oranges. In 1920 and 1921 Spain exported 7,000,000 boxes and 12,000,000 boxes, respectively, as compared with 16,000,000 boxes in 1913. Shipments from Italy for both 1920 and 1921 were close to 3,000,000 boxes, this amount being only a little less than for the pre-war year 1913. In 1921 the United States exported over 2,000,000 boxes, or more than double the exports in 1913 and 45 per cent more than the exports in 1920. Imports into the United Kingdom were about the same in 1921 and in 1913, or approximately 8,000,000 boxes. The imports into France amounted to 3,000,000 boxes for both of these years.

Regenerated Beverages.—The country is being flooded with circulars worded in the most abominable English. Here is a specimen: "It will not happen often that an offer of such solidily (*sic*) reaches you." After this preamble you are told that you can have 2½ gallons of Rhine wine, Moselle, etc., or "Beer of Munich" with "guaranteed fullbodied production," whatever that may mean. "Or if you want something stronger you can make a gallon of whiskey, chartreuse or Benediktine (*sic*) for the same money—two dollars. Samples are not shipped and orders must be accompanied by U. S. currency." Probably there are many who will learn their lesson in chemistry that alcohol cannot be made by a powder. Barnum was right.

Copper to Preserve Rope.—The Copper and Brass Research Bureau says that recent experiments by the United States Bureau of Fisheries indicate that copper will be used in the future for preserving rope instead of tar, which is used at present. Impregnating rope with tar does little good, for the marine pests literally "eat the tar out of" the rope and then devour the rope itself. Consequently, the 200,000 fishermen in this country who use annually about 200,000,000 pounds of rope have found rope renewal a costly item of expense. Recent experiments by the United States Bureau of Fisheries having demonstrated the efficiency of the copper-treated rope, arrangements have been made to place it on the market in the near future. The copper is applied in a solution of oil. Bulking less, weighing less and costing less to apply than tar, copper looms large as the rope preservative of the future.

The "Universal" and the Fireman's Gas Mask.—The army gas mask as developed during the war gave protection against all the poisonous gases, vapors and smokes encountered on the field of battle. But when, after the war, army-type gas masks were advocated for use in metallurgical, chemical and other industries where noxious gases or fumes occur, the Bureau of Mines immediately pointed out that the masks gave no protection against ammonia gas used in refrigerating plants, or against carbon monoxide, water gas and coal gas. Recently special gas masks having canisters containing absorbents designed for protection against ammonia or from carbon monoxide have been developed, but these afford little or no protection against other gases. To combine efficiently in one canister the absorbents for all noxious gases is difficult because the absorbents for certain gases are best when moist, whereas an absorbent or catalyst for carbon monoxide can be used only when perfectly dry. Hence it becomes necessary to use dry absorbents for the other gases. After an extended series of experiments and tests the following dry, granular absorbents, arranged in order of the passage of air through the canister from bottom to top were used for the "Universal" gas mask: 1. Activated nut charcoal. 2. Filter of cotton wool. 3. Caustic soda impregnated on pumice. 4. Filter of cotton wool. 5. Fused calcium chloride. 6. "Hopcalite," a carbon monoxide catalyst which causes oxidation of carbon monoxide to carbon dioxide. 7. Silica gel. 8. Filter of cotton wool. Technical Paper 300 of the Bureau of Mines gives detailed sections of the canister, also the "fireman's" canister which is smaller and lighter.

Science Notes

A Digest of Everything of General Interest Appearing in Current Literature

Saving Our National Parks. — The American Association for the Advancement of Science went on record at the recent meeting as urging the complete safeguarding in perpetuity of all national parks in the United States and Canada against every economic or commercial use of whatever kind.

Interference with Paris Observatory.—The famous Observatory at Paris may have to be moved outside the city limits on account of the tremors due to the subway. The Academy of Sciences are attempting to find a remedy and if they are unsuccessful the Observatory will probably have to move.

Colored Flowers Tabooed in Rome.—Now artificially-colored flowers must not be sold in Rome and painting the lily will probably soon be a lost art. The pure food law was applied to flowers as well, and sellers who purvey "faked" flowers will lose their licenses.

Rattlesnakes to Be Gassed in U. S. Army Experiment.—Mustard gas, phosgene and chlorine, deadly accompaniments of war, will be turned upon large dens of rattlesnakes in the vicinity of San Marcos, Tex. The experiment is to be made by special order of the chief of medical warfare, Washington, D. C.

The British Museum is conducting investigations as to the best methods of cleaning and restoring exhibits of various kinds and the reports covering the same are of great interest dealing with prints and pictures, objects of stone, earthenware, silver, iron, lead, copper, bronze and wood. The problems still awaiting solution are very numerous and varied.

Many Poisonous Plants. — Although poison ivy is one of the worst offenders it frequently is blamed for poisoning caused by other plants. The Department of Agriculture has a list of more than 100 of such plants that grow in this country, and it is probable that there are others that may be poisonous to some persons. Not all of these plants are equally poisonous, and too there is great variation in the susceptibility of persons.

Rich Radium Deposits Found in Madagascar.—Madagascar has huge uraniferous deposits which are capable of producing in the near future 40 to 60 grains of radium bromide a year. Ten tons of "betafite," the name given by Prof. Lecroix to deposits found in the Betafo district of Madagascar, furnish 15 grains of radium bromide. He adds that the crystals from which the radium bromide is obtained are found conveniently in red earth, and may be extracted by washing, as in the case of gold bearing deposits.

Deciphering Charred Documents.—Mr. Raymond Davis, of the Bureau of Standards, Washington, finds that the written and printed matter of papers that have been thoroughly charred, as, for example, by being heated in an iron box or safe, may be deciphered by placing the charred sheet in contact with a fast or medium plate for a week or two in the dark and then developing as usual. There appears to be an emanation that affects the plate except where the charred ink acts as a protective coating. It is curious that films need a much longer contact than plates, and that sometimes the effect is reversed unless the film is previously washed and dried.

Sir Christopher Wren.—The bicentenary of the death of Sir Christopher Wren was celebrated in England on February 26. Several thousand persons attended the memorial service in St. Paul's, London, the audience including many prominent British, French and American architects. The memorial address was delivered by Dean Inge of St. Paul's, who lauded Wren, not only for his preeminence in architecture, but for his versatility in mastering other sciences, such as mathematics, astronomy and psychology. Having mastered other sciences, Dean Inge said "that rare and early prodigy of universal science" took up his greatest work in middle life, and from then on his artistic genius found its expression in "the frozen music of architecture."

Damage by One Bush, $10,000.—A special study to determine the extent of infection and loss from a single bush was made by one of the State leaders of barberry eradication. The outbreak of stem rust which started from a known bush traveled in one direction, at least, for about five miles. The total wheat area affected on 18 different farms was 963 acres. The average yield for that year was only 37 per cent of what it would have been without the black stem rust, or a total loss in yield of 12,520 bushels. At a dollar a bushel the combined money loss from this single bush in this one direction was $12,520, or an average loss to each farmer of $696 worth of wheat. A barberry bush with a $10,000 potential damage possibility can be destroyed with ten pounds of salt or an hour's work with a grub hoe.

A Balloon Pioneer.—On April 7 occurred the centenary of the death of the French physicist, Jacques Alexandré Cesar Charles, the pioneer of scientific ballooning. He was born in 1746. Charles began life as a clerk in the Ministry of Finance. He devoted his leisure to scientific pursuits and he became known as a lecturer and experimenter. In 1783, a few months after the brothers Montgolfier had made their first experiments with the hot air balloon, Charles conceived the idea of filling a balloon with hydrogen. His first important demonstration was made on December 1, 1783, when Charles and his companion, Francis Robert, rose from the gardens of the Tuileries to a height of 9000 feet. Charles made his hydrogen by the action of sulfuric acid on iron. To him is due the invention of the valve, the car, the use of ballast and the employment of rubber for rendering the silken envelope gas tight. He was also the first to use the barometer in a balloon.

The Baluchitherium.—The American Museum of Natural History has recently placed on exhibition in the foyer hall the skull of the famed dinosaur, Baluchitherium, a huge extinct rhinocerous-like animal found in Mongolia by the Third Asiatic Expedition. This skull was found in the Tsagan-Nor district on the flanks of the Altai Mountains, and was transported on camel back over a thousand miles across the desert of Gobi to Kalgan, the nearest railhead, thence by rail and steamer to New York. It arrived at the Museum still partly buried in coarse sandstone. The rock was chipped and scraped away, the broken parts of the bone mended, weak or shattered parts strengthened, and the missing parts restored in plaster which is colored and finished differently from the bone or teeth so that it can easily be distinguished. One side of the skull is mostly restored, using the other side which is nearly complete, as a model. Of the lower jaw there were only two pieces and the remainder was restored from the jaw of a related but somewhat smaller genus.

Abnormal Botanical Growths.—A special exhibit of abnormal growths taken from trunks, branches, and roots of trees and shrubs has been arranged in Museum IV at Kew Gardens, England. The specimens include burrs, witches' brooms, deformed leaves, contorted stems, fasciated shoots, deformed roots, and other items. In some instances the deformity is due to injury at an early period of the plant's life; in others (as in fasciation) it may be caused by luscious growth, while deformed leaves may sometimes be a reversion to a former type. Witches' brooms are usually caused by irritation set up by fungus or insects. They are very common on birch, but occur on many kinds of trees. Burrs on trunks may follow a blow on the bark or the punctures of insects. Burrs are often very large, and the wood is prettily marked. It is in demand for furniture and cabinet work, and often commands a high price. Curved trunks are brought about by the tunneling of the larvæ of a small moth. Irregular annual rings are often caused by a tree being fully exposed to sun and air on one side and crowded on the other, says *Nature*. Roots are often deformed by growing in gravel beds or between the bricks of walls, whilst the development of aerial roots on trees and shrubs may be due to an injury or to excessive moisture.

"A Small Private Laboratory"

(*Continued from page 154*)

will be noted that the sound chamber is surrounded on three sides by test chambers, and on the fourth by the shop. The test chambers are separated from the sound chamber by the test panel. To make his tests, the observer goes into the test chamber and, by means of a peg switchboard and a stop-watch switch as already described, starts the organ in the sound chamber and notes how long the sound persists through the test panel. The test chambers, it will be noted, are quite insulated from external sounds other than those transmitted through the test panels. Other tests for loudness of sound and the vibration of the test panels are also conducted.

Remarkable results have been obtained in these sound studies. Much progress was made by the late Professor Sabine up till his death in January, 1919, but since then the work has been carried on by others. In truth, the laboratory is dedicated to the task of carrying out, so far as possible, the splendid research program that Professor Sabine had laid out for its wonderful equipment. Much data has already come out of this work, and as a consequence the architectural fraternity today begins to know the acoustical properties of plaster and brick and cement and other materials which have heretofore been used in all but total ignorance of their sound characteristics.

Plasters and Sound Waves

Curves or graphs and sheet upon sheet of figures may mean little to the laity. Realistic demonstrations are the only results which seem tangible to the man in the street. That being the case, the Wallace Clement Sabine Laboratory has much to show for its five years of busy existence. Colonel Fabyan has had prepared two test rooms for a convincing demonstration of a special wall finishing material developed by the laboratory staff. The rooms are identical in size and they are virtually empty, so that conditions are practically the same in both. However, one room is finished in the regulation manner with plain, smooth white plaster, while the other is finished with a rough, porous looking material developed by the laboratory staff. With the windows closed, we find that speech is somewhat difficult in the first room. Carpets and draperies would obviously aid the situation; but in all its nakedness the room has very little absorption for sound. The shrill note of a whistle persists for several seconds, indicating the marked reflection properties of the smooth walls. Then we pass on to the second room. Immediately we note how readily conversation can now be carried on, even though the room is virtually bare. The shrill whistle persists for an inconsiderable fraction of a second. Even a typewriter, which sounded like the bark of a machine gun in the first room, can be operated with a minimum of distraction in the second room.

These rooms form a permanent exhibit of the new wall finish developed by Colonel Fabyan's laboratory workers. Many an architect has been convinced of the desirability of using this new finish by a few moments' experience in these rooms. The rough finish, we are told, has the necessary properties for breaking up the sound waves and absorbing them so as to reduce reflection to a minimum. The new finish is quite pleasing, although up till recently it has been used in its plain, gray state. Now the laboratory has worked out a paint which apparently does not clog up the tiny interstices between the rough bits of the material, and lends attractive coloring to the wall without robbing it of its acoustical efficiency.

Sound—what a subject! There is almost no end to the study of this branch of physics. We are captured by another member of the staff and conducted to a little room, heavily padded with felt so as to reduce sound reflection to the irreducible minimum. Surrounded by an array of radio vacuum tubes, amplifying transformers, inductances, and so on, we are told that our hearing ability is to be tested. It is learned that the laboratory is making an elaborate survey of human hearing, and that the more ears that can be tested the more accurate becomes the survey. Our ears are tested for sound intensity and for range of sound pitch or frequency. The radio oscillating circuit, giving a remarkable range of sound frequencies and a ready means of varying the intensity, proves ideal for this purpose. The readings are recorded in the form of graphs, with smooth curves in some instances and jagged peaks in others. For the author's part, one ear worked at its best when the other ear was its worst, and vice versa.

Hearing Without the Ears

At this time the Colonel's staff is anxious to show you that the ears are not absolutely necessary for the recording of sound impressions by the human brain. One of the laboratory assistants goes to another part of the building in order to speak into a microphone transmitter. You sit down in a chair, and an instrument comprising a standard telephone receiver with a steel applicator coming out of the ear cap, is applied to various bones at the base of your skull. No sounds are heard from the instrument, yet when the steel applicator is pressed against the proper bones, the sounds are distinctly appreciated—we won't say heard, but they are nevertheless clearly made out. This principle is generally known, but much may yet be evolved from it as the result of proper experimentation.

Sound—an endless subject for experimentation! We are taken to another part of the laboratory where a machine enables the laboratory workers to photograph sound waves in action. Here the acoustic researchers have studied how sound waves behave and have conducted tests with models of churches and auditoriums so as to save many an architect from the worries of architectural acoustics. Provided with a floor plan and general specifications of a proposed church or auditorium, the researchers are now in a position to approve or disapprove of any project, and to make certain suggestions which will insure positive success so far as the architectural acoustics are concerned. Indeed, guesswork and hit-and-miss methods are rapidly being displaced by positive laboratory methods of insuring the desired results in advance.

Tuning forks, oscilloscopes, cameras, sound-analyzing machines, and other instruments complete the laboratory equipment for the study of sound. Perhaps the most elaborate piece of equipment is the sound analyzer for the study of complex sounds. This machine, consisting of numerous delicately balanced levers as well as glass balls for driving little wheels and graduated scales, was made in Zurich. It serves the purpose of graphically resolving into its components the resultant curve produced by any given sound, as, for instance, the sound of the letter *O*.

Then there is the human side of sound, already referred to. Colonel Fabyan and his workers are quite rightfully of the opinion that any study of sound is by no means complete if we do not possess a thorough grounding in the action of sound on the human system. So a part of the laboratory is devoted to anatomical work, wherein human ears are dissected and carefully mounted, with the various parts carefully tinted so as to bring out the different functions. Man-made ears of brass and wood and paint have been constructed to indicate the mechanics of the human ear. Nerves, especially those in the spinal column, have been studied and specimens have been obtained and mounted for study and exhibition. There is a room at Riverbank which contains skeletons of various animals as well as humans. There is a skull which has been prepared by the anatomical staff for demonstration purposes, in which the various parts are hinged in an ingenious manner so that they can be opened up one after the other to show the different skull cavities and the formation of the bone parts.

The upper floor of the Wallace Clement Sabine Laboratory is devoted to a spacious and well-appointed auditorium, where the laboratory staff meet and discuss various problems. When we visited the auditorium there were still signs on the blackboard of a lecture on the human ear, which, we were told, had been given by an ear specialist. Truly, it appears that Riverbank is already a Mecca for the scientific minds of the country to gather and impart information on the one hand and obtain information on the other.

In one corner of the auditorium we discover some kind of musical instrument, which appears to be a cross between the piano and the resident organ. There are several banks of keys. We sit down and play a few chords, and learn that the instrument is a piano. But then our laboratory staff friend manipulates a control and immediately the staccato of the piano string under the impact of the hammer, changes into the sustained tone of a pipe organ. The music, rendered either way, is delightful.

Answering our anxious query, we are told

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Botanical Notes

Dates from Asiatic Turkey.—Asiatic Turkey supplies most of the dates imported into the United States. In 1921 total imports of dates amounted to 49,000,000 pounds, of which 26,000,000 pounds came from Turkey in Asia and more than 2,000,000 pounds from Palestine and Syria.

Dr. Carver's Researches.—Dr. Carver developed 165 by-products of the peanut and 115 of the sweet potato; has made potash and chinaberry meal from the chinaberry and made a tonic for stock food from vegetable products. He also devised a dressing for canvas shoes and white and colored washes from clay; has used okra fiber for making paper rope cordage, straw matting and carpet and has made 20 varieties of laundry blueing. The Spingarn medal, given annually for the most notable achievement by an American citizen of African descent, was awarded to Dr. George Washington Carver of Tuskegee Institute for his remarkable researches in agricultural chemistry.

Worm Holes Wanted.—An American exporter sent an unusually poor consignment of oak abroad to his oversea connection, which was found to be wormy, but no market could be found for this parcel. This consignment would have caused a great loss to the exporter were it not for the fact that the consignor happened to visit an antique furniture factory. The manufacturer was at that time busily engaged in making antique grandfather's clocks, and found the oak in question to answer his purpose very nicely, because it eliminated the work of boring holes "by hand." The parcel was disposed of at a premium, and a profitable connection was established.

The Thompson Institute for Plant Research.—A statement issued recently by Dr. William Crocker, Research Director of the new Thompson Institute for Plant Research which Colonel William B. Thompson is establishing in Yonkers at a first cost of more than $500,000, gave details of the plan by which powerful electric lamps are to supplement sunlight in growing plants. "This new institution with its gardens, greenhouses and laboratories," said Mr. Crocker, "is to be to plants and flowers what the Rockefeller Institute is to humanity. In other words, it is to study and try to cure diseases of plants and flowers and other vegetation. Eventually the institution is to cost $2,500,000. Seeds from the tomb of King Tutenkhamon will be tested for germination in the new laboratory.

The Oldest Living Things.—As the largest existing organisms, the "Big Trees of California" occupy a place unique among the living things of the world, said Dr. H. A. Gleason, Assistant Director, lecturing at the New York Botanical Garden. While they may be exceeded in height by some of Australia's gum trees, as they are exceeded in diameter by the chestnut trees of Sicily, in actual bulk, said the lecturer, they are far greater than either of these. Authenticated measurements show that California's big trees have reached a diameter of over 36 feet, heights of more than 350 feet and ages well over 3000 years. Since they do not suffer from diseases and are not seriously injured either by fire or lightning, and since trees apparently do not die of old age, the usual cause of death among the big trees is by the undermining of the root system through the gradual removal of the soil by water.

Less Turpentine and Resin Produced Since World War.—Figures showing the distribution of the world's production, trade and consumption of turpentine and resin have just been published. According to the best information available, says the report, the average annual production of these two important commodities since the outbreak of the war has been from 20 to 25 per cent less than it was before the war. This is due chiefly to the decrease in the American supply, caused by the depletion of timber suitable for turpentine operations. The United States furnishes between 60 and 65 per cent of the world's supply of turpentine and from 70 to 75 per cent of the world's resin. The United States not only produces most of the world's turpentine and resin but also uses a larger part of it than any other country. Roughly it consumes between 35 and 40 per cent of the total world supply of turpentine and about 30 per cent of the resin. Forty-five per cent of the turpentine consumption is by the paint and varnish industry, and it is estimated that an additional 40 per cent is used for thinning down paint and varnish when they are applied. Forty-two per cent of the resin is used for soap making, with the paper industry second, using about 25 per cent.

"A Small Private Laboratory"

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that this instrument is not an organ in the ordinary sense. It is an electro-magnetic device in which the hammer blows are delivered by electro-magnetically-operated hammers, while the sustained notes are caused by the free vibration of the same strings actuated by electro-magnets through which flow alternating currents of the various frequencies required. Rheostats enable the player to obtain the finest kind of control of the volume. In truth, here is an instrument which permits of beautiful blending of notes not only because of the purity and the delicate handling, but also because of the remote control feature which permits of placing the strings, chimes and other sound-producing members in various parts of the building. Above the auditorium wing there is a memorial tower, in which are placed the strings and chimes, the music coming down to the auditorium with the added charm of distance. A glance in the tower discloses battery upon battery of strings, chimes, and so on, and row upon row of electro-magnets which snap away like so many small firecrackers, under control of the keys and stops in the auditorium below.

From Human Nerves to High Explosives

But the Riverbank Laboratories has other studies under way aside from those dealing with the vast subject of sound. Numerous medical studies are receiving attention, some of which have already produced promising results. Col. Fabyan, in his modest sort of way, tells us that his investigators have found out certain facts which even the larger colleges and universities, with all their equipment, have failed to find. He mentions an instance of a young lady who has done considerable research work in his laboratories, the results being published by one of our leading universities.

During the war, Riverbank was a veritable beehive of activity—it is that now, so let us say it was a super-beehive. Experiments were conducted along many different lines. Special buildings were erected for tests on high explosives and other military problems, the structures being today in practically the same shape as they were left when our national thoughts switched from scientific killing to better living.

Then there are animals of all kinds. There are bears in a sturdy cage, monkeys in another. There are animals and still more animals, because many of the medical experiments call for tests with animals in the absence of human subjects, and even side by side with human subjects in others.

Riverbank Laboratories—a vast and remarkable institution! The more one sees of its extent and activities, the more one is puzzled as to its exact meaning. After spending the better part of the day going through one building after another; witnessing various tests and glancing through ream after ream of reports on previous activities; going through the Colonel's private museum, which contains showcase after showcase with everything from a Japanese suit of armor to a ferocious swordfish; passing by the gymnasium where the human machinery of the laboratory is occasionally tuned up; visiting the "Parlor de Junk" where various pieces of furniture and scientific equipment, which have served their purpose and are no longer required, are rebuilt and refinished by skilled workmen, and then sold to the public, generally the farmers about Riverbank, the funds going toward the maintenance of the institution; visiting the picturesque windmill in which the various cereals of the colony are ground between huge stone rollers—after seeing all these things, we felt certain that we had become quite familiar with the Riverbank Laboratories. We expressed that opinion to the Colonel, which brought forth a hearty and even boisterous laugh. For the Colonel assured us that it would require at least a week to dig down into every little corner of Riverbank and obtain a real general impression of the scope of this institution.

And to make good his statement, the Colonel, after supper in his beautiful home across the way from a group of laboratory buildings, took us to a bungalow which we had not yet seen in the course of our travels about the five hundred and fifty acres of Riverbank. There was much mystery connected with this laboratory. The staff in charge moved about like so many Egyptian priests of old guarding the darkest secrets. To deepen the mystery still further, a pretty girl was brought in. We were ushered into a small booth with dull black curtains for

walls. It reminded us strongly of our psychic experiments back in New York, when we exposed one of the leading mediums after three sittings.

At the command of the Colonel, the demonstration got under way. In a few minutes we were astounded at what we were witnessing. It seemed unbelievable, yet it was there, in plain black and white. We had been brought face to face with certain facts regarding the human mechanism which we would hardly dared to have surmised in the absence of such a convincing demonstration. We were shown how—well, at this point we can go no further. Colonel Fabyan made us promise that nothing would be said about the nature of this investigation until some later date, when the experiments have progressed further. You see, science is a slowly-moving thing. Publicity is something to be shunned until the desired results are obtained. It may take weeks or months or years. Meanwhile, the public must wait until the scientists reach a point somewhat nearer to their objective.

So, big, startling things are being done at Riverbank, under the cloak of secrecy. It is such work as this, conducted by such an institution, which will unfold to us new wonders within the next few years. We shall learn more about the human body than ever before; we shall wrest certain secrets from nature which have never even been suspected; a new epoch will most likely open up. Every so often the world reaches a point bordering on stagnation, because everything seems to be fully developed, just as a field, after being thoroughly cultivated year after year, exhausts itself if fertilizer is not added. But the scientist, pegging away at the secrets of Nature, sooner or later breaks down existing barriers, opens the way to a new field, and we are soon confronted with brand new opportunities for exploitation.

And About the Man Behind the Idea

It would not be right to close this account of Riverbank Laboratories without a little sketch of Colonel George Fabyan, although we were told that the Laboratories were the thing to describe and that he was not to be mentioned. Still, the Riverbank idea is the Colonel personified, and we must therefore sketch a word picture of this remarkable man.

Colonel Fabyan, we gathered, is a self-made man and looks the part. He is a big man, well along in life but in the very best of health, as depicted by his rugged appearance. He has prospered in the cotton business. Although not a technician himself, he has always taken a keen interest in mechanics and medicine and other branches of science, and it has been his one ambition to establish a private laboratory for the purpose of prying into Nature's secrets. He devotes his time and much of his money to this work in memory of his mother, and we noted a tablet to that effect in one of the laboratory rooms.

The Colonel secures specialists in various lines and gives them every facility for developing new ideas and delving into old problems yet unsolved. The specialists receive full credit for the work they do. The laboratory workers live in what is called "The Community," which is a very essential part of Riverbank. In our short stay at this institution, we noted the wonderful spirit of good fellowship and happiness which permeates throughout the Riverbank Laboratories, as well as the admiration, intense friendship, and loyalty in which the workers hold the Colonel, who is ever interested in the activities of each and every worker.

Confidentially, we may add in closing that the Colonel has a quaint hobby—cryptography, or the ciphering and deciphering of codes. He has gathered together and studied everything available on the subject. He has compiled codes of his own and torn apart the codes of others to learn their import. He has deciphered many old-time cryptic works, such as some of the writings of the illustrious Roger Bacon of long ago. Indeed, Col. Fabyan is considered one of the foremost cryptologists in the world today. During the World War he served as a Colonel in our Army, and maintained a school at Riverbank for the training of Signal Corps officers in cryptography. The Officer grade of the Legion of Honor, the Order of the Rising Sun and other decorations, as well as rare testimonials from our own Government, bear witness to the Colonel's attainments in this quaint hobby.

And so we come to the conclusion of the story of a remarkable man and a remarkable idea which has materialized into a remarkable institution.

Sprayed Rubber

(*Continued from page 156*)

ber as yet being coagulated by the new spraying process. The latex is collected in pans and vats on the plantations and if left in the warm sun natural coagulation takes place within 24 hours. However, most of the latex is coagulated by the addition of dilute acetic acid. As it is stirred it curdles into a mass resembling whey. The curds are passed through rollers to separate out the water and it is made up into crêpe, the thin sheets that enable the buyer to see what he is buying and to judge knowingly of the amount of dirt, if any, contained. One of the faults of this process is that the acid to some extent injures the resulting rubber. Another fault is that several of the valuable minor constituents of the latex, such as albumins, resins and proteins, are dissolved and lost. With the spraying process the reverse is true—the acid is dispensed with and the albumins, etc., are retained, to the advantage of the resulting rubber.

Pure rubber would not be at all suited to most uses. It must be vulcanized, that is, combined with sulfur under low heat. This makes it more elastic in either extreme of cold or heat. If as much as 25 per cent of sulfur is used, hard rubber is produced. If red rubber is desired, sulfide of antimony is substituted for sulfur.

The spraying process is quite different. After the latex has been collected from the trees about four per cent of liquid ammonia is added to it. This acts as an anti-coagulant. Here it is the design to keep it from coagulating rather than to produce coagulation, for in the uncoagulated state it must be sent half way around the world. Those who developed the spraying process first sent from Sumatra to New York a single pint of latex with ammonia. It arrived in its original condition, so the experiment was tried next on tins, then with drums and finally, since this had proved successful, it was sent in the tanks of ships. It would seem safe to say that entire tankships may soon be used to transport liquid latex from Malaysia to this country. Units for the spraying of rubber, identical with those built in the United States have been erected in Sumatra on the largest single rubber plantation in the world. This plantation is owned by one of the rubber companies in the United States. As one unit can spray some five tons of rubber per day of 24 hours and requires a crew of only one white man and three natives to operate it, the actual cost of production is quite low.

When the ship carrying the latex reaches New York harbor a tankcar is shunted alongside and the rubbermilk is pumped into it. This car proceeds to New Durham, a suburb of Jersey City, N. J., where one of the units of the new spraying process has been erected and has, since last February, been producing sprayed rubber. The spraying unit represents what was decided on as being the most economical sized plant to operate as a unit, and any future extensions in the sprayed rubber industry will be brought about simply by multiplying the number of units. They are not interdependent. It has been calculated that all the rubber being made today in the world could be made by the spraying process in 250 of these units.

The structure which houses the rubber spraying unit consists of a truncated pyramid made of reinforced concrete. It is something under 50 feet in height and about 35 feet square, not including the sheds that surround the base of the tower. The inside of this structure is divided into two stories of unequal height, the lower one forming a huge empty room about 30 by 30 on the floor and 30 feet high, with walls that have a slight tumblehome. This is called the drying chamber. Upstairs is a room containing the spraying and air-heating apparatus, spare disk sprayers, latex tanks, and recording thermometric apparatus. A conical depression penetrates the floor between the two chambers so that the spraying disk may be lowered through it.

From the tankcar the latex is pumped into a large tank buried in the earth. Thence it reaches the small tank on the top floor of the unit. From this tank, whose purpose is to provide a small reserve supply in case of interruption of the pumps, the latex flows through a tube and reaches the center of the spraying disk in a stream the size of one's thumb. This disk is a round sheet of metal 18 to 20 inches in diameter attached in a horizontal position to the lower end of the vertical shaft of a small electric motor which gives it a velocity of 4000

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Patents and Trade-Marks

General Principles, Current Comment, and Interesting Decisions

Construction of Patent Terminology.—The courts frequently have difficulty in adjudicating patents because of the inherent flexibility of the English language and often a patent suit will hinge on the meaning to be ascribed to words used to define an invention. In Standerwick vs. Kane, the Court of Appeals of the District of Columbia held that in claims which originated in S.'s application, and therefore are to be interpreted with particular reference to his disclosure, the words "substantially constant" means "sufficiently constant for satisfactory operation"; in other words, that it was a practical and not a theoretical question.

Statutory and Common-Law Trade-Mark Rights.—That trade-marks are common-law rights of property was emphasized by the United States Circuit Court of Appeals for the Fifth Circuit in Trappey et al. vs. McIlhenny Company. It was there held that cancellation of the registration of a trade-mark, at the instance of a competitor, as a geographical name does not preclude the registrant from asserting the exclusive right to the use of the name to designate its product to which the name is applied. Where one has marked his goods with a geographical name for so long a time that they have become known in the market by that name, the use of that name to describe goods of a subsequent maker will be restrained as unfair competition.

Use of Trade-Mark in U. S. by Foreign Company After Sale of U. S. Business.—The Supreme Court of the United States in A. Bourjois & Company, Inc., vs. Katzel has rendered an interesting decision to the effect that where a foreign manufacturing company doing business in the foreign country and also in the United States sells its business in the United States with its good will and trade-marks registered in the United States, and where the assignee goes on with the business, using substantially the same form of container and label, and importing its goods from the foreign country, the foreign company cannot rightfully come to the United States and use its old marks on goods manufactured by it in the foreign country, nor can it, whether for the purpose of evading the effect of the transfer or not, arrange with an agent to sell with the old label.

Contract of Government for Use of Patent.—A decision of interest to inventors whose inventions may be of use to the Government is that of the Supreme Court of the United States in Foley, Administratrix of the Estate of Gathmann vs. United States. It seems that the inventor had offered his invention to the Navy Department, which was to test it at its own expense, and if it was found satisfactory and adopted for use, the inventor was to receive certain royalties. The court held that no contract is effected by a proposal of an inventor to give the Government the option of using his method for certain compensation, which is accepted by the statement that the apparatus will be tested, and, if it works satisfactorily, the agreed compensation will be made, where, after test, the Government informs him that the apparatus has failed, and that other methods will be used in the Government work.

Patentability in Change of Material.—Whether or not mere change of material or the adoption of a new material constitutes a patentable invention is often a moot question and no fixed rule can be laid down for it, the circumstances in each case usually controlling. The Court of Appeals of the District of Columbia (in re Curtis, decided January 2, 1923) said that where a speed governor controlled by the flow of a fluid or pulverulent material through an aperture is old and it is known that, other things being equal, the size of the device would depend on the specific gravity of the fluid or other material, the use of mercury in such a device is not patentable where the only advantage claimed is that, due to the high specific gravity of mercury, a smaller governor may be used, since this is obvious from the common knowledge that mercury has a high specific gravity and from its common use in horology.

Assignment of Patent and of Claims for Infringement Thereof.—It is quite possible to assign a patent right and at the same time make a separate assignment of rights or claims for damages for infringement of that patent. This question was passed on by the Supreme Court of the United States in Crown Die and Tool Company vs. Nye Tool and Machine Works. The effect of the decision is that where the owner of a patent executed an instrument assigning all its claims arising out of the infringement of the patent by the defendant, and all its rights of excluding the defendant from practicing the invention of the patent, the owner reserving its rights against others, and, both parties being citizens of the same State, the defendant questioned the jurisdiction of the United States Court, saying that a suit brought by the assignee under the alleged assignment does not arise under the patent laws of the United States, but is merely a suit on a contract, like one for royalties under a license, *held* that the validity of the assignment of a patent was involved, which is a question arising under the patent laws.

Infringement of Patents and Trade-Marks.—Infringement consists in the unlawful use, sale or manufacture of a patented article, without the consent of the patentee or owner, or the use by a competitor, of a trade-mark or trade name, so similar to one already in use, that confusion is apt to arise to the injury and damage of the one who first adopted and used the trade-mark.

It has been held that it is not an infringement to make a patented article simply for private experimental purposes, with a view to test the efficiency of the patent, or to improve upon the same, or for other purposes of private investigation.

The question is often asked: "Before I apply for a patent, I wish to know whether my invention infringes any other existing patent." To answer this question would entail an expense which is usually far more than the actual cost of obtaining the patent. The Patent Office, in passing on an application, does not consider this question, and it is far better to apply at once for a patent and postpone the question of infringement, which, of course, may never arise, until the patent is granted. By applying for a patent, you may obtain the benefit of an official examination as to the patentability of the invention, which perhaps may be all that you require.

All good improvements are worth patenting, irrespective of the fact that their use may be found to infringe a prior patent, and many inventors have made large sums of money in selling their improvements to the owners of the original patents with which their patented improvements can be used. Infringements occur much less frequently than most people suppose, and in general unless you have some special reason to believe that an infringement exists, the best way is not to be troubled about it until someone calls the matter to your attention. It may even be that the owner of the infringing device has an invention far more valuable than the patent with which it conflicts. A good example is that of Howe, the inventor of the sewing machine, who derived a revenue which came from the owners of two infringing patents paying him a small royalty on each machine, while the net profits of the infringing companies were many times that received by Howe.

The general rule of law is, that the first original patentee is entitled to a broad interpretation of his patent claims. The scope of any patent is, therefore, governed by the inventions of prior date. To determine whether the use of a patent is an infringement of another generally requires a most careful examination of all analogous prior patents, and an opinion based upon such research requires for its preparation much time and labor. The expense of these examinations, together with a written opinion, varies anywhere from $50 to $500 or more, according to the amount of time and labor involved in preparing the same.

Sprayed Rubber

(*Continued from page 205*)

revolutions per minute. It occupies a position slightly below the ceiling of the lower chamber. Here is the spectacular part of the process.

Reaching the center of the whizzing disk the rubber milk is instantly taken up and whirled from it in a cyclone of minutely atomized drops. Since they fall continuously they form an umbrella-shaped dome, a maelstrom of spray changing quickly to rubber in the intense heat of a draft of air heated to 500 degrees Fahrenheit in a brick furnace situated on the upper floor. This air is conducted down into the drying chamber by means of four large furnace pipes. The blizzard of spray rapidly drying into flakes of pure rubber may be observed in comfort through a tiny glass window let into the wall of the structure opposite the eyes as one stands on the narrow platform that runs around the tower.

The great heat dries the minute drops of latex spray so quickly that no injury can come to the rubber from prolonged heating. Not only is the water of the natural latex driven off but the liquid ammonia, which was added in Sumatra, floats in gaseous form through a special port in the walls. Its odor is readily detected around the unit. Before the drying latex has reached the floor of the chamber it is rubber.

The latex could be caught on the floor itself, but that would necessitate stopping the process from time to time to permit its removal. If the process is to be a continuous one the accumulated rubber must be removed frequently and in small amounts. This is provided for by covering the floor entirely with a number of narrow platforms 30 feet long by about 2 feet wide. Each platform is mounted on casters. As a filled platform is withdrawn from one side of the chamber an empty one is pushed into the other. The removal is effected by a line from a small winch hooked to the respective ends of the platform and pulled, beginning with one end so that the superincumbent rubber is parted along the division between two platforms. As the coating of rubber is continuous one would naturally anticipate great trouble in doing this, but while still warm it comes apart as easily as a couple of baking powder biscuits—and resembles them in some ways.

The platform comes out into the shed covered with a blanket of clean rubber about five inches thick in the center where most of the flakes fall and tapering off to an inch at the ends. It smells like newly baked bread. It feels like spongecake and if squeezed in the fingers it fails to return to its original form. Between the little flakes air is imprisoned, giving the mass a whitish or light cream color. While warm it is easy to break off a chunk of the rubber, but if allowed to cool all the strength of the arms cannot tear off a sliver as large as the little finger.

While still warm the large slab of rubber on the platform is broken up into pieces of irregular shape so that they may readily be handled. Twenty-five pounds of these are weighed out at one time and placed in a hydraulic press which comes down on them a moment, squeezing out all the cells of air and consolidating the sponge into a beautiful translucent mass of rubber the color of pulled taffy candy. It is now solid, and extremely strong. This rubber is ready to be vulcanized and used.

A variation of the latex spraying process is being used in the manufacture of automobile cord tires. The latex fabric made by the new process has no weft threads. These are unnecessary because the cords are held rigidly parallel until saturated through and through with latex. Then this is dried into a continuous piece of rubber. The cords are led from spools through a bath of latex which so thoroughly soaks into them that microscopic examination has revealed its presence in the center or core of the little cotton fibers, none of which in the finest cotton are over 1½ inches in length. Still maintaining a parallel relationship and, equally important, having equal tensions, these cords are led through a series of drying devices, drying the latex which is in the cotton fibers, that which is between them and that which is between the cords into a single piece of fabric which may be stretched sidewise without the least injury or permanent displacement of the cords. The fabric has been made integral with the rubber itself. The parallelism between the cords is perfect. Every cord takes up its rightful share of the stress in the tire.

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Radio Notes

A Review and Commentary on the Progress in This Branch of Rapid Communication

The Broadcast Central Station has now been operating in the heart of New York City for several months, and has been functioning very well indeed, especially in view of the unfavorable summer weather and the location of that station in the heart of the metropolis. The Broadcast Central is really two stations in one—WJZ and WJY. The two lofty steel towers which rise some 400 feet above 42d Street, New York City, provide support for two antennæ, and this super-station transmits two broadcast programs simultaneously, on different wave lengths. WJZ transmits on a 455-meter wave length, and WJY on 405-meter wave length.

Broadcasters' Correspondence. — Since the inauguration of broadcasting by WGY some sixteen months ago, the General Electric Company has received 65,000 letters from listeners scattered over the United States and from points as widely apart as Hilo, Hawaii, and London, England; Vancouver, Canada, and Valparaiso, Chile. Some of the letters are typewritten and from the offices of business and professional men and some are penciled on scraps of paper from woodsmen and from forest rangers. These letters are useful to the program director for he learns from them what type of program appeals to the majority of listeners and the letters strongly influence his decisions in building up future programs.

Marconi's Recent Work.—In a statement issued to the press on his arrival at Southampton on board his yacht "Electra" recently, Senator Marconi said that during the two months he had been away on his research cruise he has been working all the time on the system of directive wireless telegraphy, by which a message could be sent in one direction only, and he was delighted to say that experiments had proved highly satisfactory. The apparatus with which he had been working was the only installation of its type, but it was likely to come into universal use in the future. The results he had obtained proved that communication could be maintained over long distances. The new system, said the Senator, effectively eliminated atmospheric disturbances, and he might say that he had experienced no trouble of that sort during the whole of his two months' research. The course of the trip was roughly 2200 miles, or the distance from England to Canada.

Proposed Broadcasting in India.—According to recent dispatches, it was announced at the broadcasting conference held in Delhi that the Indian government did not intend to permit broadcasting in India by individual firms, but, under reasonable control—as in the United Kingdom—by a single licensed company for the whole of India. It is planned that this company shall consist both of British and Indian firms and that no non-British subjects will be allowed to take part in it. The proposal of the government regarding terms of the agreement required of the broadcasting company were embodied in a draft form of license placed before the conference. Opinions upon this form will be obtained from the Provincial governments and chambers of commerce. It is understood that the manufacture of receiving sets is to be undertaken in India as soon as practicable by the new broadcasting company. This will probably at first consist of importation of some parts, the local manufacture of others, and assembling of complete sets.

Loud-Speaker Voice for Drill Sergeant.—If 250 lusty-lunged sergeants of the regular army should get together and shout "Fall In," in their best drill-ground style, the effect would scarcely equal that of the voice amplifier recently purchased by the Signal Corps and installed in mobile form on a motor truck. The new equipment can be used to handle large bodies of troops, to make speeches and music audible to assemblies, or to supply entertainment received by radio. The apparatus is technically known as a public address system. Sounds are picked up by a high-grade transmitter placed a few feet from the speaker, or near the bandmaster's stand, if music is to be handled. The electrical output of this transmitter is increased about a half-million times, using a four-stage vacuum-tube amplifier. Then the current goes into a group of six horns, mounted on a folding tripod. Under ordinary quiet conditions, a compact crowd of 750,000 people could hear a man speaking in an ordinary voice, through the use of this system.

The Wireless Year Book.—The 1923 edition of "The Year Book of Wireless Telegraphy and Telephony," published every year by the Marconi's Wireless Telegraph Company, is bulkier than ever. This may be ascribed to the advent of broadcasting which has caused an interest in radio matters to be generated in many new places. Though there has been no marked progress in scientific development during the year that most useful feature, the "Record of Development," still makes interesting and informative reading, and the value of this is much enhanced by Mr. Platt's "Historical Survey." On the other hand, large power wireless stations are being constructed in every part of the world and in many ways wireless or radio is becoming more and more a part of our daily life. All this is reflected on the Year Book by an enlargement of the existing features and by the publication of fresh matter relating to direction finding. A map section shows the location of every wireless station in the world.

Radio Telephony in South America.—In Santiago, Valparaiso, and several smaller Chilean cities interest in radio telephony is growing steadily, and its fuller development only awaits the establishment of a broadcasting station within the country such as those now in operation on the east coast of South America, according to a report from the Department of Commerce. It is reported that broadcasting stations recently erected in Buenos Aires, Montevideo and Rio de Janeiro are giving very satisfactory results, and large numbers of amateur receiving sets have been sold in these countries. This is especially true of the Argentine, where conditions for broadcasting programs are almost ideal as the land generally is flat and radio transmission carries all over the River Plate district, Uruguay and in Southern Brazil on the north as far as the Andes on the west. For this reason the sale of radio equipment has met with great success in that country, and it is now estimated that there are approximately 25,000 sets in Argentine Republic, in comparison with about 100 less than one year ago.

Wired Wireless, or the application of radio telegraphy and telephony to power wires and other continuous conductors to form a "guided" system of radio communication as distinguished from the usual "unguided" system, is about to receive a practical test in broadcasting operations. There has been formed an organization for the purpose of broadcasting talks, news, musical numbers and other features over the lighting lines of a power company in the vicinity of New York. The plan is to charge a nominal fee to the electric light consumer for the privilege of listening to the wired wireless programs. The company undertakes to supply a receiving set which may be plugged into any socket or receptacle. A simple receiving set with crystal detector and a pair of ear-phones is supplied at the lowest fee; a single-tube set is supplied for a higher fee; and a three-tube, loud-speaker set complete, giving the same service as a phonograph, is supplied at the highest fee. The tubes are supplied with filament current directly off the lighting current, from the same plug connection that receives the radio energy. Plate batteries or "B" batteries are still employed, since it would require too elaborate an arrangement to do away with them, and the current consumption for the plate circuit is such that "B" batteries last for long periods. The wired wireless programs are to be of a high order, and are to cover a period of some eighteen hours out of the twenty-four. On occasion, the broadcasting station plans to pick up programs from other broadcasting stations and to retransmit them over the power lines. It so happens that wired wireless has many advantages over the usual "space" radio, among them louder signals and less static interference.

Psychic Adventures at Home

(Continued from page 164)

and feet roped in such fashion as the furniture makes convenient. She is supposed to be tied in a way that she could not have accomplished herself, unaided; for while one hand and arm could have been used in tying the other, the second arm presumably could not have been tied without external aid. The medium is freed in the same way in which she was tied, after a lapse of time depending upon the pleasure of the control. Other phenomena may or may not occur during the interval.

McKenzie, originally vastly impressed by this performance, ultimately learned that it was done by means of a trick tie. The right hand was tied, honestly, using the left; the left wrist was slipped into a loose noose in the rope, which was then twisted in such fashion as to give the impression, to any other than a most painstaking searcher, that it was properly tied. McKenzie did not charge Miss B with conscious or even unconscious trickery. He insisted that Black Cloud had been playing pranks on his own account, to have sport with the investigators.

If a trick tie were used last year, I cannot testify that it is still used this year. Black Cloud announced that the tying was to be done, and the ropes were trailed across the hands of several of the sitters, while one could hear whipping sounds as they were passed around and drawn tight. When the job was completed, the red light was ordered and we were invited to examine the work. With McKenzie's findings in mind, I thought I should have been able to identify the trick tie if it were used; but I was unable to do so.

Before the tying had commenced, Black Cloud got Sir Arthur and me to exchange seats, bringing me into the place next the medium. My left hand was then picked up, brought in contact with Miss B's right, and it was to this hand of mine that her right was tied, rather than to any of the furniture. No question arises as to the honesty of this tie, for her hand was in my control, regardless of whether the tie were a valid one.

When the light was called for, my freedom of examination was somewhat hampered by my being thus tied to the medium; I could not pass around behind her and examine her bound left hand from all sides. This hand was tied to the longitudinal member of the table along which the two ends slide—the runner, I shall call it. The rope passed several times about this, and several times about the medium's wrist. Her wrist lay tightly against the runner, with a large, complicated knot in the rope between. None of the loops of the rope passed clear around the wrist and the runner in one turn; every loop passed about the wrist alone, or the runner alone. So far as I could determine, every loop actually passed into the knot, and I could not see that any two consecutive loops passed about the wrist. If these observations were accurate, all the orthodox ways of making a trick tie from which and into which the hand could be slipped at will are covered.

While the ties were being examined, Dr. Pyle produced a handkerchief and suggested that, before she was released, something be done with this as clinching proof of her nonparticipation in the actual work of the seance. Black Cloud accepted this idea, and when the light was extinguished the handkerchief lay, open, on the table near the medium. Almost at once the tinkle of a tambourine was heard, and Dr. Pyle announced that the handkerchief had been brought to him in the tambourine, neatly folded. Then it was gone; and after perhaps two minutes the control called for the light. When this was turned on, we had to look about quite a bit before we located the handkerchief, tied tightly around the medium's face and neck, over her mouth.

My first thought was of her left hand, and I looked again at it. So far as I could judge, the rope was arranged just as it had been before. The extreme speed with which release and retying would have had to be accomplished, in the light of the facts set down in the preceding paragraph, not alone lend some force to the argument that release and retying could hardly have been done; they likewise make it highly improbable that these operations could have been done with so little disturbance of the rope as to escape my eye.

Examination of the state of the handkerchief was, for the moment, quite staggering. This I could do with excellent effect, for the knot was on my side of the medium's face. The kerchief was smoothly and neatly folded

as it passed over her mouth and around her cheeks. It was drawn so tightly that the flesh of her cheeks overflowed very sharply over its edge; and it was with difficulty that I could slip a finger under it, at the expense of the flesh rather than of the cloth. The ends were properly and firmly and unmistakably tied, at the back of her neck.

I must confess that I was tremendously impressed. But subsequent thought brought forth one suggestion which indicates that a natural explanation is not quite so hopeless as it seemed. Tight as it was, the handkerchief could doubtless have been pulled around, moving the knot from front to back and vice versa. If the medium had a free hand, the handkerchief could, I am quite confident, have been tied, with that hand and the teeth, and with the knot in front; and then pulled around and tidied up a bit, in the position where we found it. And this not alone throws the handkerchief trick right back upon the question of whether the medium really had a hand free, but gives a suggestion that maybe the teeth were used in tying the left hand as well. I don't know just how they could have been used; but obviously they constitute a tool which we have not yet mentioned, and with an additional tool the medium, if she be a sleight-of-hand artiste, could obviously do more than without it.

The very obvious explanation of confederacy I am afraid will have to be thrown out; if this medium does her stuff by trickery, she does the tricks herself. She has never given this handkerchief performance before, so far as I know, but everything else that she did for us on this evening parallels what she has done for McKenzie at the British College, and for Sir Arthur at his home in Crowborough. None of the sitters of April 26th was present at the College, and of these sitters Sir Arthur himself is the only one who was present at Crowborough. This rules out confederacy; and I would point out that the stage magician does most of his stuff with the aid of not one, but several confederates, all over the house and all over the space back-stage. If he were left wholly on his own resources, he would have great difficulty in giving so creditable a performance as the one I am describing.

After the light went off again, Black Cloud got an inspiration of his own. He called for soft instrumental music, and the whistling voice joined in from the center of the table as usual. While this went on, the medium's right hand carried my left to her mouth. The avowed purpose of this was to enable me to verify that the handkerchief was still in place. But my hand was held, back against this handkerchief, long enough for me to make two other observations of prime importance. One was that the medium's head was unquestionably in the place where it belonged while the whistling came from the center of the table. The other was that while the whistling proceeded, the medium was breathing through her nose—gently, regularly, and *not* in time with the whistling.

The suggestion has been put forward that Miss B's independent voices are on her phonograph records. It is a very natural plea, under all the circumstances. I will not meet it by insisting that the voices come from another point than the phonograph, because, as it happens, I can do better than that. Some time ago Miss B held a series of test sittings, at which a very good friend of mine was one of the investigators. In the medium's absence and without her knowledge, the records were played; and nothing was found on them that did not belong there. Had I not known this, I should have asked permission to play one or two of them after this seance.

Well along in the seance we had another remarkable demonstration in connection with these records. Mrs. Lee, now alone and now with the aid of the controls, has been feeding music into the machine, now from one pile and now from another, ever since the beginning. Of the records offered and rejected, some must have been restored to the "live" piles, since these would surely have given out otherwise. Some tunes apparently were so restored after they had been played, since they were later repeated. In the original sorting, Miss B took the records just as they came. It seemed, therefore, quite out of the question, even if by a feat of memory she knew their order in the several piles to start with, that she could have kept track of the condition of any of the piles.

A record ran out, and Mrs. Lee replaced it. Before she had it completely on the

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machine, and hence before it had played a note, Pansy objected that she didn't want that one. Mrs. Lee asked her, with a trace of impatience, how she could tell whether she wanted it before she knew what it was. Pansy replied promptly and in unusually good voice that she knew quite well what it was, that it was "The Tale of the Roses," and she didn't want it and wouldn't have it. It was laid aside for identification, when the light should be restored, being placed upright in Mrs. Lee's chair, behind the lady's back. Presently, forgetting that it was there, she leaned back and cracked it. At the end of the seance, this broken record was found to be the one that Pansy had named. If we admit the good faith of Mrs. Lee and the impossibility of Miss B's knowing by memory what this record was, we have here something that comes perilously close to passing the bounds of telepathy and falling in the field of pure divination.

From time to time various of the sitters announced caresses or other touches; those that came to me were just about like the ones I had felt in previous seances, and call for nothing beyond the mere chronicling.

That two voices never appeared at once I am quite certain; also that no two objects were moved about the table at the same time. It is my impression that several times we had lights and voices simultaneously, but of this I cannot be absolutely certain.

Several of the sitters at one time or another announced the cold breeze so characteristic of the seance room. Once Sir Arthur and I got a powerful blast of this; there could be no mistaking its objective character, or the fact that it came from the direction of Miss B.

Toward the end we had a gorgeous example of table tilting. Black Cloud announced it in advance, and called for all the hands to be placed in light contact, at the very edge of the table. My left was an exception; it remained well out on the table, with the medium's right beneath it. Knowing what was coming, I purposely bore down as gently as possible; and twice, for my pains, I had my hand pressed more firmly upon hers, by what I took to be her left hand. Aside from this, her left was unaccounted for.

The table gave a few premonitory shivers, and then rose, to everybody's very positive belief, entirely clear of the floor. Suspended in the air, it gyrated in a curious back-and-forth, up-and-down fashion, which I can describe no better than to call it a figure-of-eight motion. Presently it settled back to earth.

I handled the table considerably during the clearing for action, and I judge it weighs fifty pounds at least. I am perhaps not as strong as the medium, being built along the general architectural lines of a drink of water; but I could not come within forty miles of juggling the table as it was juggled, if I had two arms and two legs to work with, from a well-balanced position. The suggestion has been made that only the top of the table was levitated; but the top displayed no tendency to come away when we hauled the table around to free the rug—and besides, I don't believe that Dr. Pyle has a conjurer's table in his dining room.

The grand climax of the Besinnet seances, spiritistically speaking, is the materialized faces. Here a word of explanation is in order. Mr. James Black once poked the finger of scorn at this medium, because one of her materializations turned out to be Miss B herself, out of her seat and lying over on the table. Had Mr. Black known a little more about the subject, he might have pointed the same finger of scorn, but from a different direction. It is admitted by the medium and her supporters that the "materializations" are not always independent of her own physical form. The claim is that when the power is good she gives off sufficient ectoplasm to form a complete face or even a complete figure; but that when the power is less, she can only produce enough of this substance to be used as a mask or veil, over the foundation supplied by her own face. Her face is then thought of as having been "molded" ectoplastically into a resemblance to the features which it is desired to present.

Now of course this seems ludicrous to the scoffer—even the spiritualist understands that, if he has retained his balance. Maybe it *is* ludicrous. But it will never be demonstrated to be ludicrous by simply calling it so; a reason for its absurdity must be produced. Until this is done, Miss B's good faith cannot be attacked by the mere demonstration that some of her materializations are, or could be, her own face in disguise. So I shall not bother to discuss this possi-

bility at all; I shall merely describe what happened.

After the seance had been under way for a half hour or so, there occurred what the regular sitters recognized as an attempt at materialization. A psychic light was produced of different character from those that had gone before. It was more static and brighter, standing quietly in one place. A short distance away, in the direction toward the left hand of the sitter facing it, there appeared a vague object of some sort, illuminated by the light in question. To me with my lack of prior knowledge as to what it was supposed to be, the first of these objects seemed quite without form. They continued to occur, at intervals, with the light ever brighter and the illuminated object ever better defined; until I was able to assure myself that an attempt was really being made to delineate the human face.

The lights accompanying these "faces" were, at their best, of considerable illuminating power, once or twice actually making one of the sitters visible faintly to his neighbors.

One who has sat with Miss B has expressed privately to me the opinion that these lights are from a small electric torch. They did not so impress me—principally, I think, because the illuminated region did not show a definite circle; also because the luminous entity itself impressed me rather as a surface than as a curve like the filament. But they do not last long, and one's attention is directed at the accompanying "face" rather than at the light; so such a verdict should be put forward with much reserve.

The illuminated objects themselves, as I have said, ultimately get to the point where one believes they are meant for faces. There the thing halted for some time. Sir Arthur made desperate attempts to identify the materializees, asking again and again to have them repeated. Ultimately he satisfied himself that one was his nephew and another his mother. Sitting next him, I saw these particular ones almost as well as he did, and it was my own best judgment that they were not sufficiently clear to be identified at all, save by a liberal contribution of desire and imagination on the part of the sitter.

Had some convulsion cut the seance off half an hour earlier, I should have carried this impression away as a final one. During the last half hour, however, I was forced to revise it. From six to a dozen faces were within this period presented, either to me or to an immediate neighbor, which were startlingly clear and which lasted long enough for one to get them in one's eye. While all of these seemed in a way to be types rather than individuals, yet I was pretty sure that if any of them were the face of one known to me, I should be able to identify it. Some of these faces were female and others male types. All, I believe, had the eyes closed; repeatedly a sitter would plead "If you would only open your eyes I believe I should know you." They were quite diverse, and I did not feel that they could all be the medium's face without make-up of some kind—ectoplasmic or otherwise, as you prefer. All of them were, to my best judgment, quite generalized in appearance—lacking entirely, for instance, such personality and character and distinction as I had noted in the singing voices. And herein, I think, lies the danger of claims to identification.

Concerning the structure or apparent structure of the faces I should want to see more. Some if not all were surrounded by fabric-like structures similar to the "ectoplasmic arch" which Sir Arthur finds on most psychic photographs. As regards the features, my best impressions would be rather unfavorable to the suggestions involving a textile fabric of some sort. All the faces were singularly reposeful in general effect, and had the corpse appearance.

The Maple Sugar Industry

(*Continued from page 176*)

as the purest water. But it is as susceptible as milk to bacterial influence. And it is only by preventing the development of these organisms that a high-grade product can be made. This is done by keeping the sap at a low temperature, by concentrating it at the earliest practicable moment and, more than all else, by the most scrupulous attention to cleanliness in every particular. The sap is gathered daily, poured into a large tank which is set upon a low sled, taken to the boiling place and drawn by gravity into the storage tank, whence it flows, also by gravity, into the evaporator, the amount being

so regulated by carefully adjusted floats as to maintain a uniform depth as shallow as is consistent with safety.

The boiling place of an up-to-date plant is a substantial frame building of three rooms, exclusive of a shed for the storage of an ample supply of fuel. The main room is used for the evaporation of the sap. A smaller room is for the concentration of the syrup into the form of sugar, and the third contains the storage tanks, which of late years are of heavy tin, though formerly wood was the material exclusively used in their construction. The evaporator, of which there are many styles, consists essentially of a battery of shallow pans set upon a cast-iron arch, in which a blazing fire is constantly maintained. Several of the pans have corrugated bottoms, thus exposing a greater surface to the action of the heat, and they are so arranged that the sap flows in a continuous course from one into another, constantly becoming more concentrated, being held in the last compartment until its boiling point is approximately at 219 degrees.

It is then drawn off and filtered through flannel cloths or felt strainers to remove the mineral matter held in suspension in the sap. This consists chiefly of a compound of lime with malic acid, technically, calcium malate, but locally known as "sugar sand," and also as "niter." Until very recently this has been considered as of no value, and thousands of tons in the aggregate have been thrown away. Recent investigations, however, indicate that malic acid, a substance selling around $10 a pound, may be extracted at a very nominal cost, and the stuff promises to have considerable commercial value in the near future.

But the filtered syrup is placed in a deeper pan, returned to the fire, and further concentrated to the desired density. If designed for maple syrup, it is standardized at a temperature of 219 degrees, making an allowance of one degree for every 500 feet of variation of altitude. It is then removed from the fire, again filtered, and poured into the containers, which are then hermetically closed. At the present time the gallon can, made of tin and fitted with a screw-cap, is the container most in evidence. If designed for a soft sugar, the syrup is concentrated to a temperature of between 229 and 234 degrees, as desired, the former representing an 80 and the latter an 85 per cent sugar, respectively. And a temperature of 242 degrees indicates a 90 per cent product. This is as far as it is practicable to concentrate the syrup in the thin-bottomed sheet-iron pans in universal use in the United States, but the Canadian maker, using thick, cast-iron kettles, is able to concentrate the product to a water content of only 5 per cent.

The cost of an equipment for operating a maple sugar-making plant is about one dollar per tree, exclusive of the boiling-house, which may be as elaborate and expensive as one may please. The labor cost of collecting and concentrating the sap varies greatly, but it is generally assumed that one man and team can gather and attend to the boiling of the yield of 500 trees. Under the most favorable conditions he may be able to do much more, and under unfavorable conditions he may not be able to do nearly as much. During the past few years many maple sugar makers have installed systems of spouts which take the sap either directly from the tree or from convenient stations and convey it by gravity to the storage tanks, thus largely reducing the labor cost. The only other cost is that of fuel. This, of course, varies according to local conditions, but it is calculated that one cord of good wood, rightly handled, is sufficient to concentrate a sufficient quantity of sap to make 1000 pounds of sugar.

On account of the cost of production and the comparatively limited quantity which it is possible to produce, maple sugar can never compete with cane or beet sugar for general purposes. But as an auxiliary to supply the table with a most delicious syrup, and also for use as a confection, it is playing its part to the limit in conserving other forms of sugar.

Our Reserves of Energy

(*Continued from page 182*)

The upper atmosphere contains enormous stores of electrical energy which are continuously being regenerated by solar radiation, winds and other influences. No doubt the day will come when great towers will be erected for tapping this vast supply. The chief difficulty in the way now is that the atmosphere, even when damp, is so poor a conductor that a single tower can tap only an insignificant portion of the field. The presence of a small amount of radium, however, makes the air a conductor of electricity for a considerable distance around it. And it is very likely that we shall one day find a much cheaper means than this for rendering the air a conductor, so that towers built a considerable distance apart can tap large fields of atmospheric electricity.

There are still other promising methods of developing the sun's heat. A pet dream of the writer has been the conversion of sun's heat direct into electrical current by the use of the thermal couple. When a schoolboy, he constructed an apparatus consisting of a number of thermal couples connected in series so that by burning a candle or even a match he was able to develop a small continuous current of about a volt for experimental purposes. There is nothing against applying the same principle to the generation of the sun's heat except the large initial cost of plant involved. It is not unlikely that this difficulty will some time be obviated.

We need never fear exhaustion of fuel, for it will never come. We will slowly cease using it and begin using other sources of power as economic considerations dictate. But it will be a development so gradual that we will not be conscious of it. It is beginning even today.

The Inventor and the Gay Gambler

(*Continued from page 151*)

"This machine can be played with a soft flannel shirt. It is absolutely noiseless, no complicated parts and nothing to get out of order. It is the only machine on which there are no strings or rubber bands. We make this machine to operate with either a knee-spread or a straight leg movement, as preferred," etc.

The central mechanical contrivance of all these affairs is a fine folding and extending device of some kind, varying greatly according to the make of the holdout. Some of these extending devices are like the folding steel lazy-tongs used on telephones at office desks. Others work on the pneumatic principle, the arm being extended down by a pressure of air. What hasn't been devised today will be in the market tomorrow. The variety never is exhausted. The inventor never tires.

We come now to that other celebrated instrument of gaming, the roulette wheel, made famous by Monte Carlo. It has often been said that this is one of the fairest games for the amateur, and this may be true enough if the wheel be operated as at the famous Monaco resort. There the roulette wheel contains the usual thirty-six numbers and a single "green" or zero. A dollar bet on any number pays thirty-five for one, the bettor receiving his dollar back, of course. So, if you bet on a number, the bank has thirty-five other numbers and the zero against you. The percentage of the bank is thus one out of thirty-six. When roulette was adapted for American use, however, another "green," the double zero, was added, "for the police payoff," as a famous gambler once told me. Since the rate of payment on our wheels is the same as abroad, 35 for 1, this change has simply meant an additional chance against the player. In Europe he is payed 35 to 1 for playing 1 to 36. Here he gets the same pay for playing 1 to 37. The gambler's percentage is thereby doubled. Instead of being a little more than three per cent, it becomes about six and one-half. This alone is a ruinous handicap for the player, but nothing of that kind satisfies the gamekeeper as we know him today. With all due respect to the fraternity, the only absolutely "straight" wheel now operating to my knowledge is at Monte Carlo. I do not know personally about Cuba, but what reports have come my way are not reassuring.

The roulette wheel came into America about thirty-five years ago. Since that time inventors have constantly improved on the methods used for its corruption. One early and obvious contrivance was a little mechanism which applied a brake, first to the rim and later to the axle of the wheel. The wheel was allowed to run until it had almost lost its momentum. Then the croupier or an assistant leaned against a lever which applied a brake just after the heavily played numbers had passed the ball. The wheel came to a stop and the ball naturally fell into the pocket corresponding to a table-number which was being played lightly or not at all.

Next came the knockoff or mule's ear, a small sliver, neatly cut out of the track in which the ball revolves about the numbered wheel, which is rotating in the opposite direction and so affixed to a button that it

can be pushed out at the right moment to trip the ball and cause it to fall into a pocket in that quarter of the wheel where no heavy bets lie. This was soon afterward improved by changing the mule's ear to a fine needle, which jumped out in the same way when the croupier chose to stop the ball and cause it to fall where no big losses impended.

Another inventor soon devised a wheel for those roulette devotees who like to play red and black at even money. In this machine the partitions between the alternate red and black pockets of the wheel were raised and depressed in turn. The croupier, if he saw that red was being heavily played, took the ball and spun it to the right with his left hand. Almost invariably the ball fell into a black pocket. If the big bets lay on the black, he spun it to the left with the right hand. The raised and lowered partitions did the rest—the ball fell red. It was a good trick unless someone discovered that the ball was not always being spun in the same direction.

Soon came a more brilliant adapter than all these, with a roulette wheel made up of two pieces, an inner saucer and an outer movable rim, but so cleverly fitted together that no eye could discover the joining. What happened? If I played a stack of chips on 18 and the ball actually fell into that socket, the croupier instantly touched a lever and the inner saucer moved over one space, leaving the ball reposing in 31 or 6, the neighbors of 18 on the wheel. This beautiful atrocity also had its day and went its way.

Electricity, of course, was not slow to be applied to the roulette wheel. Here again we have the electro-magnet controlling a ball with a steel core, as in the dice game on the showcase. The magnet was placed under the wheel at a certain place, controlling an area of perhaps ten numbers, whichever spaces happened to be passing over it at the time the switch was connected. The croupier began turning the wheels and spinning the little ball with the steel heart. As long as all went well there was no cheating, but as soon as some player got to winning consistently, the dealer watched the numbers on which the chips were piling up. Now, as the wheel spun around, slowing toward the stop, the croupier waited until a quarter of the wheel passed over the magnet. Instantly he stepped on the switch and the ball dropped into a losing slot—losing for the player. Such wheels are still in common use wherever the fair lady Fortune is allowed to spread her perilous skirts.

The many cheats at roulette, all of them dependent upon a visible control of the ball or the wheel by the croupier, led to a demand for a covered wheel. The theory was that if the wheel were concealed after once the ball had been spun, so that neither the player nor the croupier could see what was going on until after the ball had come to rest and the lid been lifted, it would be quite impossible to commit such gross frauds against the infatuated player. As a result, covered wheels were immediately provided, both fair and foul.

On one of these pages you will find photographs of such a covered roulette wheel. In playing, the cover is not placed in position until the bets are laid on the cloth or table. When all bets are down, the croupier carefully places the lid in position and spins the ball or marble in the funnel at the top of the lid. The ball soon drops down through the neck of the funnel and, still spinning, passes through one of the holes in the under side of the lid, which you may observe in the raised cover. When the players have heard the ball fall into its pocket, the croupier raises the lid and—lo! not a man has won a bet.

The reason for this ill luck (Sic.) is not far to seek. From the neck of the funnel a concealed tube or track runs to one of the openings in the lower face of the double cover. In some of the best machines this tube is a coil, so that the innocents may appear to hear the ball rolling about inside the lid. But whatever the arrangement, the ball always makes its exit from just one hole. This winning hole is situated at the point marked on the cover by the screw-head with the vertical slit, directly facing the reader in the illustration. The gamekeeper simply waits till all the bets are down and then places that screw-head directly over a number on which there are no bets. Inevitably, he wins and you lose. If you ask him to put the lid on before you lay your bets, you are but little better off. He sets his lid so that the exit hole rests on one of the partitions between two numbers. When the ball falls it does not enter a pocket but is held up against this partition. It can now be turned into the pocket at the left or the right by a slight twist of the lid in lifting. The croupier naturally turns the lid in such manner that the ball falls into the numbered pocket that profits the players little or not at all.

The gambler-inventor is still at it. This is what he has done to date. Tomorrow's marvels may be more deeply desolating. Moral: Barnum was right.

Doing Away with Dots and Dashes

(*Continued from page 183*)

on an antenna current varying from zero to hundreds of amperes. Thereby, to employ a picturesque phrase of the Signal Corps, "the ether of space is bombarded with a mass of frequencies never twice alike in the same letter."

A gain of more than 150 per cent in the speed of the transmission of telegraphic signals is claimed in behalf of the sending of the Morse alphabet or code by the radical method outlined. In fact, the outstanding advantage of revision of the International Morse alphabet appears to be its accomplishment of facilitating a dispatch of a maximum volume of telegraphic traffic with the use of a minimum number of signals. The Signal Corps has sketched a graph indicating the relative speeds of the International Morse alphabet, the Morse alphabet, and the newly proposed system of transmission. This exhibit, while showing an increase of 150 per cent by the use of the latter method, does not completely measure the advantage in this particular. The existing Morse cable alphabet involves the sending of some of the letters by adjacent signals of the same sign, although the signals occupy equal periods of time. For instance, in letters such as "a" or "1," three or four signals have the same sign. The alphabet proposed by the Signal Corps indicates that no two consecutive signals shall duplicate the same sign; thus, for the first time a continuous wave of one definite frequency is used for the alphabet. Such an arrangement permits of the utilization of electrical and mechanical tuning, either or both.

A chart drawn by the Signal Corps illustrates the method of modulating a single frequency wave, the principle involved in the proposal of dispensing with the time element in the sending of code and distinguishing the dots, dashes, and spaces by the varying intensity of the signals. It is arbitrarily decreed that the largest amplitude represents a dash, the median amplitude a dot, and the smaller or zero amplitude is reserved for representation of the space necessary in the transmission of the telegraphic code. This method has been practically demonstrated by engineers in both the United States and England. The principle involved in this system of sending code renders it possible to modulate a single radio frequency by a number of modulating frequencies, and thereby multiply the capacity of each radio frequency channel.

This revolutionary theory with reference to a revision of the mode of transmitting the International Morse alphabet likewise contemplates a reduction of "static" or atmospheric disturbances, the constant bane of radio reception during the summer months. In this system of transmission very low modulating frequencies are employed, and according to the Signal Corps, it would seem relatively easy to devise instruments that shall be selective as between the low modulating frequencies and the higher frequencies of atmospheric and other natural disturbances. A chart prepared by the Signal Corps shows that a modulating frequency as low as ten cycles per second, which is considered a very high frequency for ocean cable practice, corresponds to 75 words a minute. This by far exceeds any form of sound reception. A modulating frequency of 60 cycles a second, the normal power frequency, corresponds to a speed of 450 words a minute, with five letters to the word.

If traffic dictates a reduction of this speed, according to this system of sending code, this may be accomplished by making the same perforations in the tape of the transmitting apparatus correspond to a suitable even multiple of a semi-cycle. To illustrate, by making each of the signalling units correspond to six complete cycles of current, instead of one semi-cycle, the rate of sending radio signals is curtailed to 37½ words a minute. This approximates the speed of commercial traffic. Thus, it is seen in this new method of sending the telegraphic alphabet, wave trains or frequencies are used as the elements for signalling.

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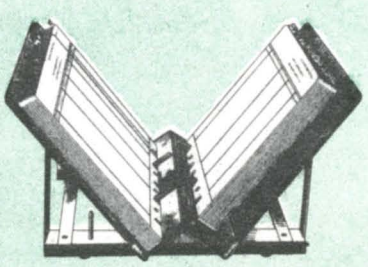

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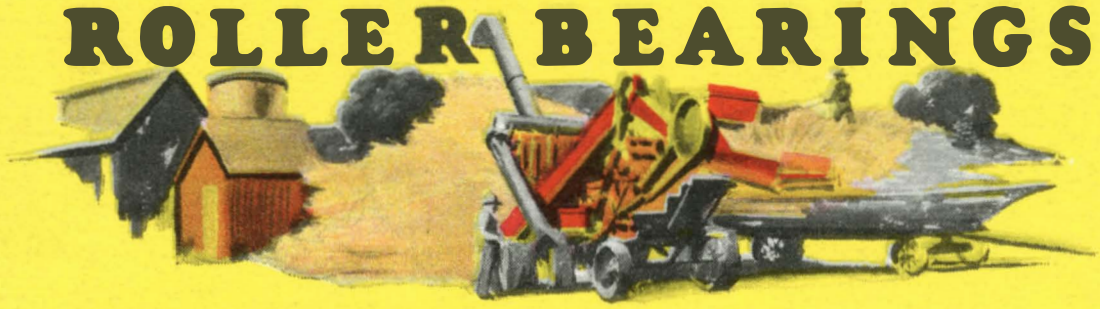

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