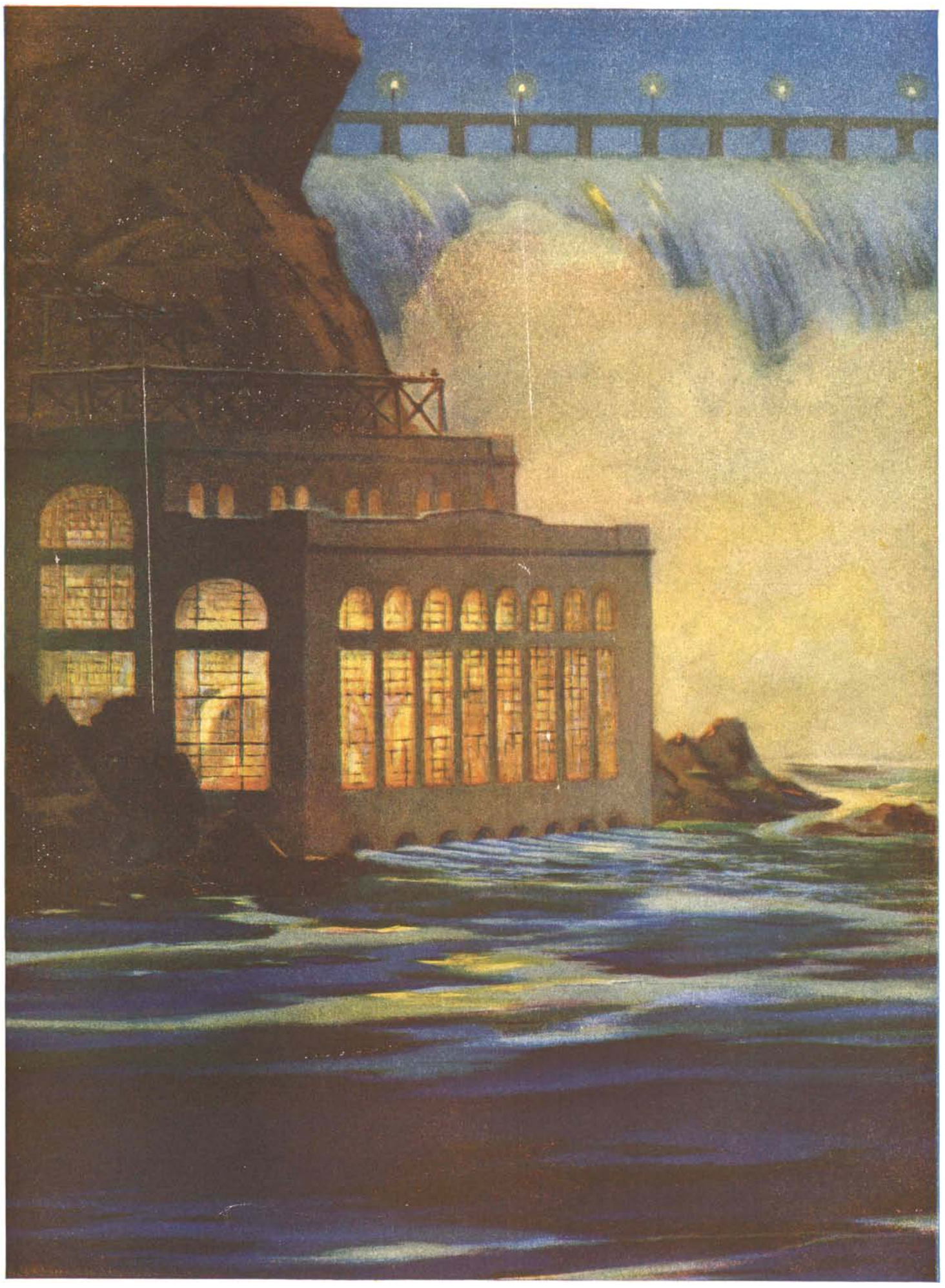
ELECTRICAL NUMBER

SCIENTIFIC AMERICAN



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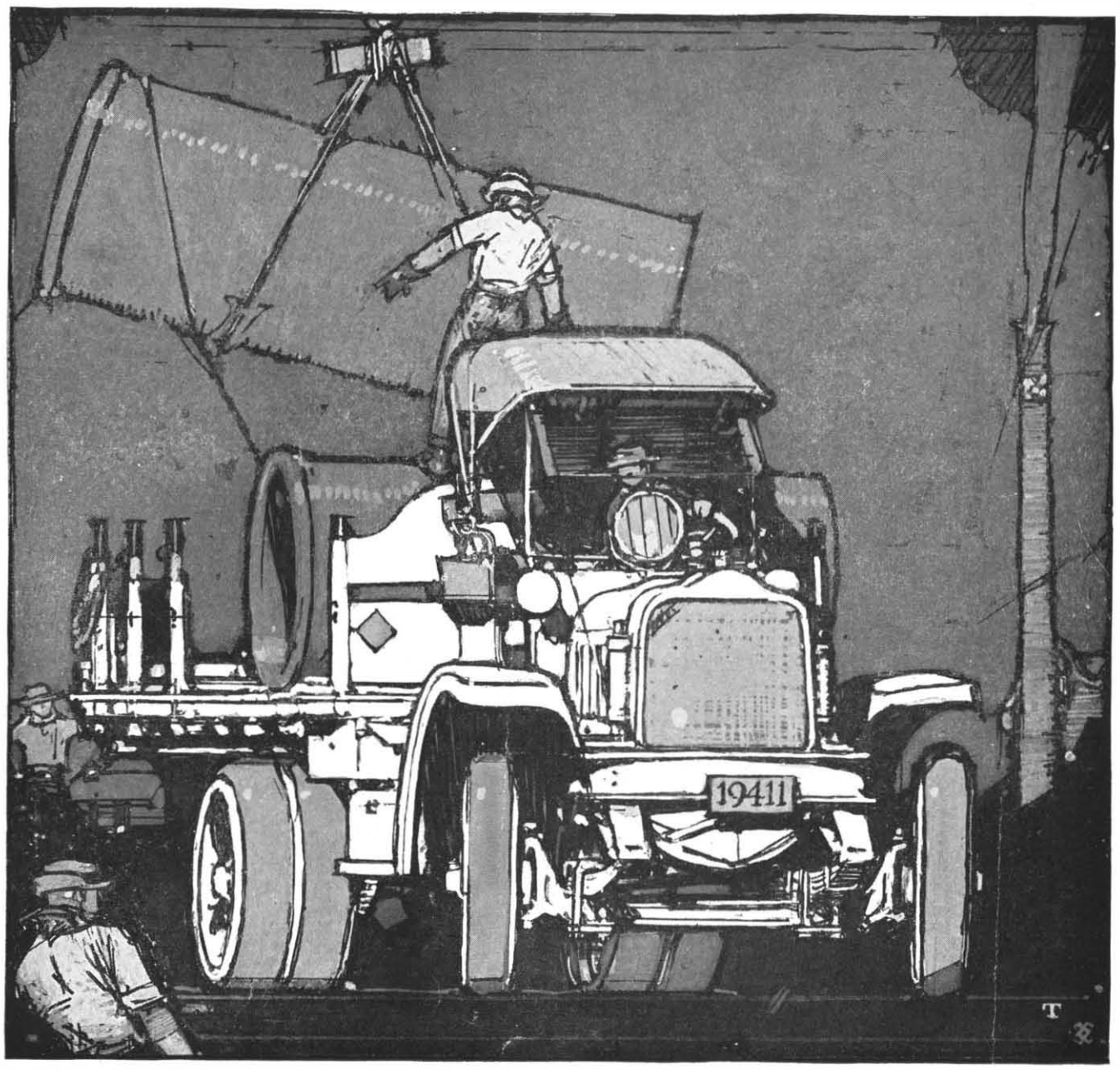

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SEVENTY-SECOND YEAR

SCIENTIFIC AMERICAN

THE WEEKLY JOURNAL OF PRACTICAL INFORMATION

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A Reservoir That Will Float

A German Solution of the Difficulties of Subaqueous Concrete Work

By J. F. Springer

THE problem of constructing concrete works beneath the surface of the water is one that has engaged the serious attention of engineers all over the world. The earlier methods of depositing concrete in bags or of dropping it without any protection through the water are apparently obsolete, or nearly so. Highly approved practice permits the laying down of concrete by means of the tremie, provided the proper technique is followed. Indeed, the modernized methods of handling concrete by means of the tremie promise to become the standard procedure. But alternative methods exist, and will apparently continue to be used, since they give good satisfaction in many connections.

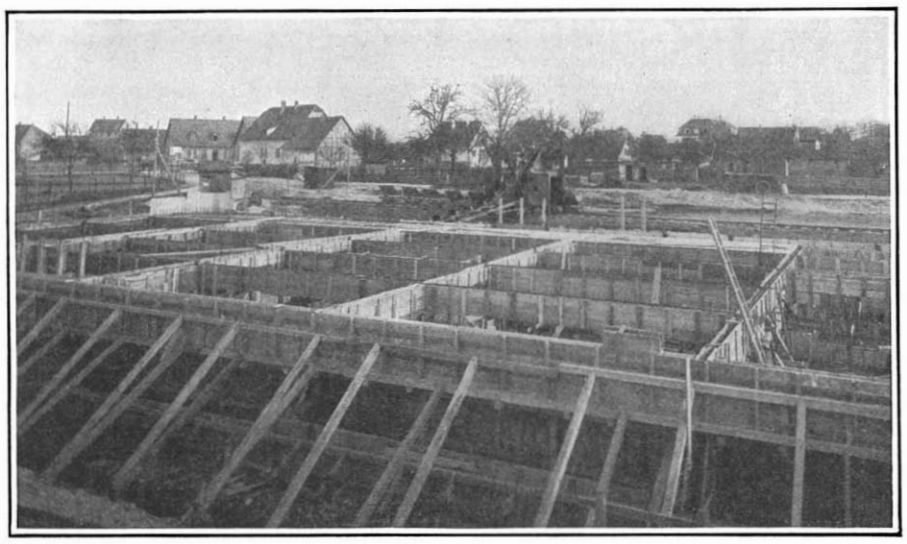
For instance, concrete is often placed below the water level with the assistance of the open coffer-dam. By this procedure the water is simply dammed off from the building site on all sides and the concrete laid in the dry. This is the method that was employed in the construction of the great concrete dam and lock across the Mississippi at Keokuk. In another system concrete is placed beneath the water in an atmosphere of compressed air. This process has been frequently used in the placing of the concrete in the bases and cores of the foundation piers for such tall and heavy structures as the Woolworth Building, the Singer Tower, etc.

There is still another method, analogous in a way with the mode of construction utilized for the collapsed central span of the Quebec Bridge. That is to say, the shell of the structure is put together at any convenient point, and then floated to the final position. Naturally, in doing this, the shells have to be designed to displace their weight of water with incomplete submergence. The specific gravity of concrete is about 2.33. Accordingly, the volume of the concrete in the shell must be considerably less than 0.43 of the gross volume of the entire mass. It is necessary also to provide against the hydrostatic pressures which must he supported by the sides and bottom. The proper strengthening of the bottom especially of an extensive shell may become a considerable problem. The method has always the great advantage of curing the concrete in the dry. If the structure is to be solid, it is built and floated hollow, and filled after it reaches its permanent site. This procedure has been carried out in connection with harbor improvement projects in Kobe, Japan, and Victoria, British Columbia; and a noteworthy inland application has been made at Strassburg, in Alsace.

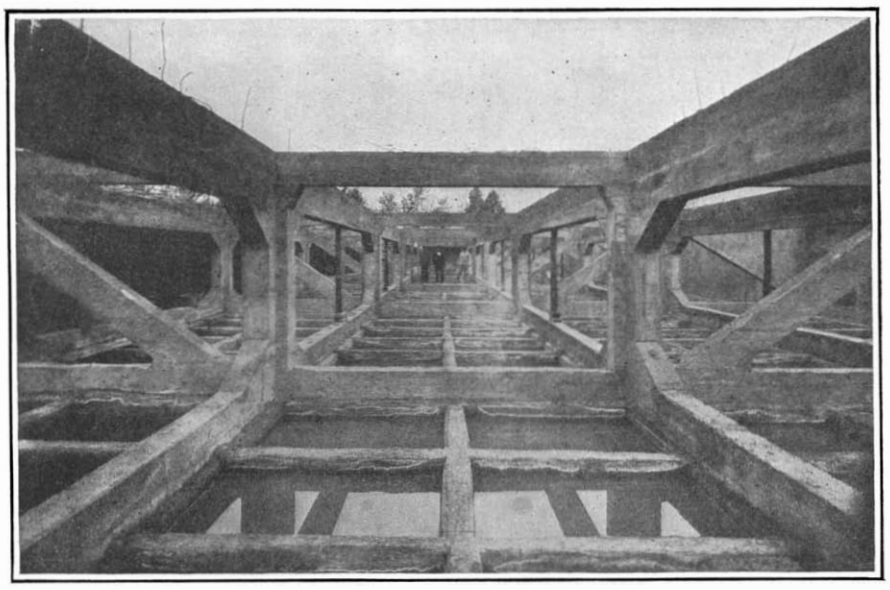
A large basin was required here in connection with the disposal of part of the surface water from sudden downpours, the basin being planned to receive and accommodate temporarily all water beyond the immediate capacity of the overflow conduit. It was to have horizontal dimensions of 49 x 164 feet.

The site is a low-lying one, where the ground water is encountered about 5 feet below the surface. The structure was of course to be a hollow one when finished. The side walls of a big coffer-dam might have been constructed of sheet piling, entirely enclosing the site, and keeping the water from entering from this quarter when the earth was removed from inside. But the bottom of the excavation would still remain. As this bottom would consist of porous gravel, there could be no possibility of unwatering the site and maintaining it dry. If the side walls were made thoroughly tight, and securely pinioned to the soil back of them, a concrete bottom would have solved the problem; but it would have been necessary to lay this at least 40 inches thick in order to overcome the upward thrust of the water from a head of 81-3 (5 + 31-3) feet.

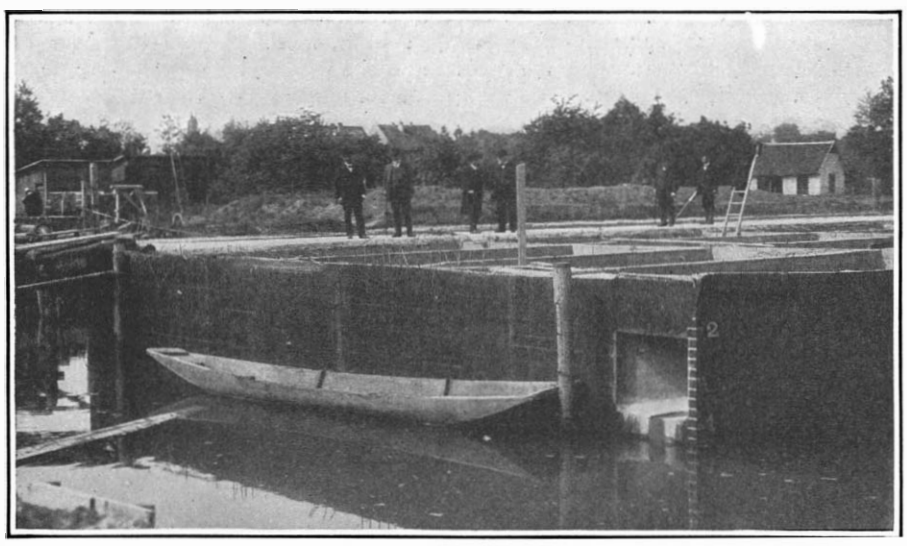
This would have been quite expensive, not merely on the ground of the concrete used, but on that of the additional excavation necessary. Natural conditions, however, made the floating caisson method possible. In the neighborhood of the site is a stream whose upper surface is some 4½ feet higher than the ground water level. The idea was accordingly conceived of constructing the basin in the dry at a location close to the site and at such a level that water admitted from the stream would float the structure. If this could be done, then the basin might be floated to a position exactly over its final place and proper means taken to sink it. This plan was carried out.



Construction site with frames ready for pouring



Interior of the basin, showing arrangement of side and bottom bracing



Floating the concrete basin to its permanent site. Note the concrete skiff

The structure itself was given a height of 8 feet. There was therefore available for flotation purposes about 4¼ feet of water. It was hardly practicable to use the whole of this depth for the submergence of the basin; a certain amount of water was needed under it to develop the upward pressure necessary for flotation and to provide against irregularities. The facts that the specific gravity of concrete is low, and that the structure could be made with a decidedly thin shell by the advantageous use of internal braces, made it possible to float the basin with much less than the maximum available submergence. When finished and cured it drew a trifle less than 3 1-3 feet.

Naturally, a structure like this had to depend largely upon steel reinforcement for the strength necessary to withstand the water pressures on sides and bottom. The manner in which this need was met is very well shown in our illustration.

The casting of the basin was done in a pit whose floor was carefully prepared to give proper rigidity and drainage and to prevent adhesion of the basin. After being poured upon this surface, the basin was given six weeks to mature.

The adjacent and final site was of course prepared before the basin was shifted. When completely excavated, it contained water reaching nearly to the level of the construction floor in the other pit. After a suitable surface was gotten ready beneath this water, the two pits were thrown into one and water admitted from the stream, converting the two sites into one large pool with a sufficient depth of water to float the basin. The big ungainly concrete box was then dragged over to its proper location.

It had been proposed to sink the basin to its final level by loading it. This plan was abandoned, in part at least, and the water withdrawn by pumping until the natural level of the ground water had been attained. During this process, sand was sucked out of the gravel at one end of the site, weakening the bearing capacity. Moreover, it will be readily understood that perfect leveling of the permanent bottom could not be attained, since this work had to be done under water. As a consequence of the irregularities thus existing, and of the subsidence of the gravel bed mentioned, there were produced considerable stresses in various parts of the big box. The bottom slab, however, proved to be sufficiently elastic to accommodate itself to the resultant bending movements.

In the work, mentioned above, at Victoria, B. C., concrete cribs 80 by 35 feet in section and 39 feet high were floated to position and sunk. Individually these cover a much smaller area than the Strassburg basin; but the height brings the gross volume up to a very respectable total. The sinking was here provided for by the opening of sea valves. Fifty-four of these cribs were used, and they had to be floated 3 miles from the point of launching to the final position.

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

The Scientific American and the Electrical Week

BEGINNING to-day, December 2nd, the entire country is joining in a week's celebration of the marvelous progress of electricity and of the practical achievements in this field of industrial activity. Electrical shows are being held all over the land, and by means of lectures, street parades, store window exhibitions and the like, the people of America are being reminded of the debt we owe to electricity.

It is particularly fitting that America should celebrate an electrical week for in no other land has so much been done toward the development of electricity. In electrical progress we have been the leaders. It is fitting also that the SCIENTIFIC AMERICAN should join heartily in this celebration for the history of the SCIENTIFIC AMERICAN is coeval with that of commercial electricity.

It was in 1845 that Charles Wheatstone and W. F. Cooke substituted electro-magnets for permanent magnets in electro-magnetic machines. This practically marked the birth of dynamo-electric machinery. It was in the same year that the SCIENTIFIC AMERICAN was born and since that date, only one year after the successful opening of Morse's experimental telegraph line between Washington and Baltimore, the SCIENTIFIC AMERICAN has been writing the history of electricity week by week. This chronicle started two years before the birth of Thomas Edison. In it may be found all the achievements of electrical inventors during the past seventy-one years. It is therefore with justifiable pride that we join in celebrating America's Electrical Week.

In the following pages will be found articles by authorities on the present status of various branches of electricity, with hints on future developments. Our land is such a progressive one, our people so taken up with the work of to-day and to-morrow that we have little time for reminiscences. For this reason we have omitted historical matter and devoted these pages to the story of electricity of the present and the future. Thereby the SCIENTIFIC AMERICAN is merely continuing its biography of electricity.

Electric Drive for Rolling Mills

THE driving of rolling mills is one of the most puzzling problems the power engineer is called upon to solve. The difficulty arises from the very quickly changing character of the load. Before the billet is entered between the rolls the only work the steam engine or the motor is required to perform is the very trifling amount necessary to turn the rolls themselves. But immediately the rolls take hold of the billet the power rises to a maximum, which may be several hundred or several thousand horse-power, according to the size of the rolls and the nature of the work they have to perform. Then when the billet emerges from the rolls on the other side, the whole of the power previously absorbed is instantaneously set free, the pull on the engine or motor reverting to the initial conditions. The period of rest, however, is very short, only sufficient to allow of the billet's being re-entered between the rolls for the return pass; and again as soon as it is so entered and the rolls have gripped it, the power rises to a maximum, though usually, by reason of the reduced cross-section of the billet, not quite so high as the first. This alternate no-load and full-load goes on until the billet has made all its passes; the power required being less at each pass, but for a longer period.

The first difficulty that confronted the electrical engineers in their attack upon this problem was the question of meeting the requirements of the generating station. It is a very serious matter to any generating station to be subject to such very violent fluctuations in the demand for current. Where lights are supplied from the same service, it would mean a universal dimming of these at the moments of maximum load. And in addition to the very obvious strains imposed upon the generators, it happens that with modern methods of electric power distribution over large areas by the aid of three phase alternating currents, heavy demands for current lead to somewhat serious induction troubles.

The difficulty has been met in the same manner as with the colliery winding engine; in fact, the apparatus employed for driving rolling mills is a development of the electric winding engine. A large fly-wheel again employs the useful office of absorbing the power that would be running to waste in the intervals between the different passes, and giving it out to aid the current taken from the service during the heavy starting and accelerator periods. The interposition of the fly-wheel protects the electric supply service from the heavy demand that would be made upon it during the early portion of each pass if there were no such attachment. The full power released by the emergence of the billet from the rolls is of course not available to assist during the starting period, as some is eaten up in overcoming the friction of the fly-wheel itself and it may be of other parts of the machinery; and therefore the economy to the user is not so great as it would be were he allowed to take directly from the service all the current he requires. On the other hand, if a central station did allow such an arrangement, it would be obliged to make higher charge for the current, and the cables employed to deliver it to the iron works would have to be very large in order to avoid a lowering of the pressure at the motor, of considerably greater magnitude than necessitated by the starting requirements.

What Will We Do for Science?

IT is but a short time since one of the livest issues confronting the scientific world was the problem of impressing the lay mind with the paramount importance of organized scientific research on a grand scale. Two years of world warfare have done what decades of exhortation could not have accomplished. On all sides the point is conceded; deliberate and intensive investigation of all fields of pure science and science as applied to engineering and production has at last taken its proper place in the national and individual consciousness.

Are we going to let it go at that? Is this, like so many other things, to be accepted and promptly forgotten, put to rest in the limbo of the things we know and never think about? Is it to be laid upon our mental table, thus becoming everybody's business and therefore nobody's business? Will we in the future leave this vital factor in our national existence, as in the past we have left it, entirely in the hands of the few who look for direct and rapid financial profit from some isolated phase of it? Or will we take it out of the world of business, with its insistent demand for immediate commercial results, and put it under such auspices that the larger problems may be approached with a proper scientific spirit and with due regard for their manifold correlations?

Within the next week or two Congress, in regular session assembled, will decide what the answer shall be for the year 1917. The Federal Government has for some time possessed, in the Bureau of Standards of the Department of Commerce, an ideal agency for the prosecution of the work of which we speak. Our readers will recall that in our issue of July 8 some idea was given of the activities of this Bureau, and their broad application to practical manufacturing problems. But such work requires money. The investigations in a given field which can be conducted on $100,000 exceed in value far more than ten times those which are possible on $10,000. And in all fields combined, first class work is a matter of several millions rather than of several thousands.

In past years Congress has seen fit, here as elsewhere, to economize on the smaller and less spectacular aspects of the government's work so that it might with a clearer countenance of virtue squander the public funds in large and spectacular ways. And this year, unless the legislative mind can be made to see the error of its ways, the same procedure may be looked for. Special committees have charge of military, naval and postal appropriations, of the budget of the Department of Agriculture, and of the other items of the government's expenditures which can in any way be construed as political issues or vote-getters. But the Department of Commerce is not so fortunate as to fall in this category. It is cared for in a General Appropriations Bill, along with a countless horde of other items---executive, judiciary, etc., etc., etc.—which are supposed to make no appeal to Vox Populi. And where all the tendency in the special appropriations is toward inflation, in the General Appropriations Bill it is always the case that economy is the watchword. Congress goes merrily on year after year, saving its pennies and spending its pounds.

The requests of the Bureau of Standards, as embodied in the preliminary estimate submitted to the general appropriations committee, are always modest. They are always cut in half or quarter or even smaller parts. This year, in view of the tremendous field before the Bureau and the necessity, greater than ever, of covering it well, its requests are more than modest. They should be granted in toto, even if Podunk Four Corners has to go without its new postoffice and the dredging of Gooseberry Creek to make it navigable for rowboats of deep draft as far as Blaney's Bridge has to be postponed for another year. Of utmost importance to the Bureau and to the Nation, they are so insignificant beside the grand total of our expenditures that there can be no possible warrant for applying the cheese parer to them. It is sincerely to be hoped that Congress can be made to see the matter in this light, and to set a precedent of giving this most worthy of Government Bureaus what it honestly requires.

Congress and the Water Power Problem

IN the undeveloped water power of the United States the country possesses a national asset whose potent value is too little appreciated. Estimates based on careful surveys give the total capacity of all the sites at which water power could profitably be developed as 60,700,000 water horsepower, this total including both water power that has been developed and that which is now running to waste. Expressed in terms of steam horsepower, this would represent the consumption of 340,000,000 tons of coal at an expenditure of $680,000,000 per annum. Of this total some 6,538,434 water horsepower is now being developed, which is only about 10.5 per cent of the whole amount. Furthermore, the development of water power is to-day practically at a standstill, and this for the reason that the necessary capital cannot be induced to invest in water power projects.

The reason that it is difficult to secure the large amounts of capital which are necessary to finance hydro-electric projects is to be found in the unsatisfactory character of the laws, Federal and State, covering the acquisition and use of water power. It goes without saying that all legislation affecting the development of our national resources should look both ways; on the one hand, it should protect the interests of the country as a whole, and on the other, it should invite the activities of the engineer and capitalist by assuring the investor of the unhindered development and permanent security of his investment.

That these results are not secure under the present laws is shown by the fact that of the total existing development, 3,500,000 horsepower have been developed at sites not requiring Federal permits, while less than 2,000,000 water horsepower have been developed at sites requiring Government permits. That is to say only 3.9 per cent of the water horsepower available at sites requiring Federal permits has been developed, while 25.2 per cent of the water power available at sites not requiring such permits has been developed. If these figures prove anything, they show that water power development in this country has been held back by the want of reasonable laws governing the Federal authority under the granting of such permits.

It has been urged that there exists a monopoly in the ownership and control of hydro-electric power in the United States; but facts brought out by investigation in the report on the subject of water power development made by Mr. Merrill to Congress, show that not only does such monopoly not exist, but it is not even threatened. We have seen that at present only 10.7 per cent of the total available water horsepower in the country has been developed, and it must be evident that even if this entire development were in the ownership of a single corporation it would not constitute a monopoly of the available water power, or anything approaching it. In the report referred to, it is shown that eighteen Public Service corporations control a little over 35 per cent of the total six and a half million water horsepower development. Even if the eighteen corporations were controlled by a single interest it would not constitute a monopoly of existing developed water power. Particularly will this appear when we consider the vast available water power open to development by competitors as soon as reasonable legislation has been passed.

Furthermore, the principal uses to which hydro-electric water power will be put are such as will tend towards a wide diversity of use and ownership. Thus, hydro-electric power will take the place of steam for the operation of railroads. It will give us cheap and unbreakable rails, rolled from steel made in the electric furnace. It will give an enormous stimulus to the various electro-chemical industries; and, by means of nitrate fixation in the atmosphere, it will furnish an abundance of relatively cheap fertilizer for the farmer.

The SCIENTIFIC AMERICAN gives place to no one as the earnest advocate of the conservation of our natural resources. But we believe that some of the leading advocates of conservation have allowed their zeal to run away with their judgment, and that they have lost that perspective view which is necessary in considering all great national questions. There should be regulation and most careful oversight in granting permits for the use of water power, of course; but it is possible to conserve in a broad and generous spirit, free from class prejudice, and aiming, first and last, at the general good of all concerned.

Electricity

Variety of Flashlamps for Londoners.— According to the *Electrical World*, electric "eyes" in studs and buttonholes have been added to the endless variety of pocket flashlamps as aids to London people in their movements after dark. Women in the West End have been noticed of late using tiny electric bulbs, which are connected by a cord to a battery.

Cost of Electric Welding.—Recently compiled figures on electric welding in railroad shop repair work are of interest. One railroad company which employs this method reports that the total cost of this process during one week was $106.62, while the cost of the same work if done by other means would have been $1,779.04, representing a net saving of $1,672.42 in favor of electric arc welding.

Handy Switches for Electric Appliances, which are introduced in the flexible current-supply cord, are becoming more and more popular. These switches, made in a variety of styles, serve two purposes: first, they make the turning on and off of the current a simple matter, since it is not necessary to reach up for the usually inconvenient socket; second, they take the load off the socket and insure safety.

Lighthouse Helmets for London Police.— Another novelty of darkened London is a policeman's helmet provided with a small electric bulb on the very top, serving as a sort of a beacon to pedestrians and street traffic. The electric bulb is connected to a battery fastened on the belt of the "bobbie," by means of a flexible conductor.

Flood-Lighting As a Means of Renting Apartments.—Not so long ago Mr. Roy M. Gregg, manager of a real estate property in Kansas City, Mo., made a tour of the East with a view to gathering ideas on flat management and marketing. The big idea that Mr. Gregg brought back, however, was the flood-lighting of office buildings. So upon the completion of a block of apartments he decided to flood-light the three-story buildings by night to direct attention to them. His plan was more successful than he had anticipated; in less than a month he leased 44 apartments.

A Lamp Whose Cord Is Always the Proper Length is among the recent electrical novelties. It is provided with a reel which carries 30 feet of lamp cord and fastens to the ceiling or beam by means of a swivel joint. The swivel joint enables the user to walk in any direction, and an automatic lock holds the reel after the lamp cord has been paid out. A slight pull forward unlocks the ratchet and the reel turns in the opposite direction, winding up the cord. The height of the lamp can be maintained at the desired point, each time the cord is wound back, by means of a stop plug on the cord.

Sorting of Beans by Electricity.—A most ingenious application of electricity is covered in the invention of A. Weigl of Munich, Germany. Its object is to sort coffee beans by color, and each bean is subjected for a short time to a constant beam of light which is then reflected to two selenium cells. These control electrically the movement of a hopper which deposits the bean into one of several receptacles. This method, which depends upon the reflecting power of different colored beans, appears to be rather intricate, and in view of the slowness with which the average selenium cell functions, it would be interesting to know how fast the machine can operate.

Disappearing Footlights.—For the stages and platforms of auditoriums, halls, theaters and churches, where a footlight is sometimes required but at other times would be in the way, there has been developed a disappearing footlight. It consists of a complete section 3 to 5 feet long, which can be mitered to fit any stage curvature, or in longer straight sections. The new footlight can be provided with a single or double row of lamps with two or more color combinations. The top of the footlight is inserted flush and floored in to form a part of the stage floor. The footlights are mounted on the lower side of the door which is so hinged that by pulling it up a slight distance the lamps are brought into position. Ordinarily, the door is closed, and the footlights are not in evidence.

Telephoning from a Tug Boat is soon to be realized on the craft engaged in New York harbor service for the Lehigh Valley Railroad. It is planned to equip the pilot house of each tug with a standard telephone instrument, so that the captain can get in touch with the tug dispatcher the moment the tug touches one of the company's piers, over a private wire leased by the railroad. Cut-in boxes are now being installed on the ends of each of the Lehigh Valley piers in New York, Brooklyn, Jersey City, and the Bronx. Connections between the cut-in boxes and the telephone apparatus aboard the tugs will be made by flexible cables, with the same facility as the tying up of a boat to the pier.

Astronomy

Solar Eclipse of 1918.— The U S. Naval Observatory, with the coöperation of the Weather Bureau, is preparing for publication a pamphlet giving astronomical and meteorological data relative to the total solar eclipse which will be visible over a wide range of longitude in the United States on June 8th, 1918.

The Warner and Swasey Observatory. — According to *Popular Astronomy* the private observatory which Messrs. Warner and Swasey, the well-known instrument makers, have maintained for the past twenty-five years in Cleveland is to be given to the Case School of Applied Science and moved to the campus of that institution. The donors have also undertaken to enlarge the building by the addition of two wings.

A Report on the Moon.— Those who deplore the fact that observations of lunar topography and possible changes therein are neglected nowadays by the majority of astronomers will be gratified to note the large amount of interesting material collected in the seventh report of the lunar section of the British Astronomical Association, just published. This report contains an extensive collection of drawing and detailed descriptions from many observers. Prof. W. H. Pickering presents an epitome of his well known views on the subject of lunar changes.

The Best Time to Observe Mars.—In one of his recent lectures the late Prof. Lowell took occasion to correct the belief, widespread even among astronomers, that the near or so-called "favorable" oppositions of Mars are best suited to the observation of the canals. The facts are, it appears, largely the reverse, for it happens that the earthward presentations of the hemisphere where and the season when the canals are most visible occur together during the farther oppositions of the planet. The opposition of last winter was one of these generally neglected but actually favorable occasions.

Stereoscopic Views of the Sun.— The stereoscope has recently been applied by Prof. Hale to the study of the sun. Two photographs of hydrogen flocculi surrounding a large sunspot group near the sun's limb were taken with the spectroheliograph at an interval of seven minutes, giving just about the minimum angular separation of the objects sufficient for stereoscopic vision. Viewed through the stereoscope these pictures give a distinct effect of relief, and Prof. Hale believes this process may aid in clearing up some of the questions referring to relative levels of solar features.

Comet or Meteor?—On the evening of May 4 Messrs. Perrine and Glancy observed at Cordoba Observatory (Argentina) an object resembling a comet, with a tail eight or ten degrees in length, but showing the unheard of proper motion of 10 degrees within an hour, at the end of which time it had passed below the horizon. If it was a comet it must have been very near the earth to show such a displacement. It was moving toward the sun, the shape of the tail was fairly permanent, and the tail was, as always in comets, directed away from the sun. An alternative possibility is that it was a meteor trail of unusual persistency, but it did not undergo the distortions to which such trails are generally subjected by shifting air currents; possibly because it was at a very high altitude, where atmospheric movements are supposed to be comparatively uniform. A telegram was sent to Harvard Observatory, in the hope that the object might be picked up by northern observers, but no other observations seem to have been reported.

The Parallax Campaign.—A feature of the recent (nineteenth) meeting of the American Astronomical Society was the series of reports on the measurements of stellar parallax in which a number of observatories are now coöperating. The principal observatories identified with this work are Greenwich, Mt. Wilson, Yerkes, Allegheny, McCormick, Sproul, Dearborn and Van Vleck. The last named, situated at Middletown, Conn., is not yet actually taking part in the observations, as the 18-inch object-glass ordered for its new telescope has not yet been obtainable on account of the war. The equipment at Sproul Observatory, Swarthmore, Pa., has only recently been installed, but the director was able to report parallaxes for 64 stars. The work at Sproul is confined chiefly to visual binary systems, though some large proper motion stars have also been observed. At Dearborn Observatory, though many photographic plates have been made in this work, only a few have been reduced, owing to defects in a measuring machine, which had to be returned to the makers. From McCormick Observatory 96 parallaxes were reported, as the result of two years' work. Adams, of Mt. Wilson, reported tests, by his new method of line intensity, of 28 parallaxes obtained by Van Maanen with the 60-inch reflector. The relative intensity of certain lines in the spectrum of a star gives an indication of the star's absolute luminosity, from which, knowing the observed brightness, the parallax may be deduced.

Invention Notes

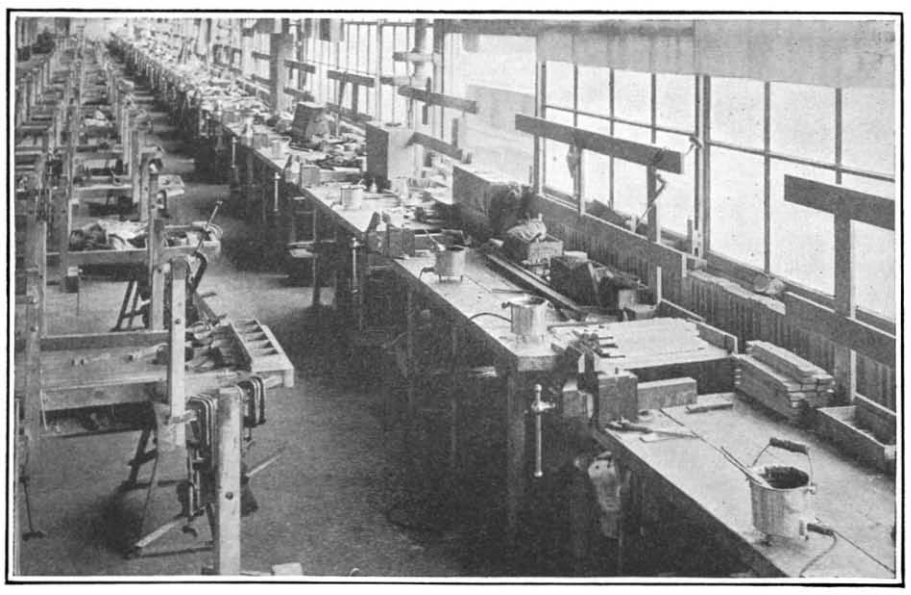
Death of an Electrical Inventor.—There recently died in Baltimore, Md., James Frank Morrison, who was the inventor of a number of electrical devices and the pioneer in many important electrical movements and enterprises. Mr. Morrison began his electrical career in 1862, when he entered the telegraph service of the Baltimore and Ohio Railroad Company. In 1878, while night manager of the Western Union Telegraph Company, he built what was then regarded as a long-distance telephone line, extending 200 miles from Georgetown, near Washington, along the Chesapeake and Ohio Canal. From 1880 to 1887 he was identified with one of the pioneer motor service companies, and did much work in the development and commercialization of the series motor.

New Tire Testing Tank.— The tire-testing tank in the average garage is generally a disreputable bit of equipment consisting of an old tub or half a barrel, filled with water which has done repeated service until it is so dirty that it is with difficulty that any leak in the tire is located. A new testing tank which is being called to the attention of the trade is made of glazed porcelain and stands on a pedestal which makes the use of the tank much more convenient than the tub reposing on the floor, and renders observation of the tire much easier. The glazed surface of the interior of the tank plays a valuable part in locating the leak by reflecting the bubbles as they rise from the inflated tube submerged under the water. When desired this apparatus may be connected to the regular water supply so that clean water may be had at any time.

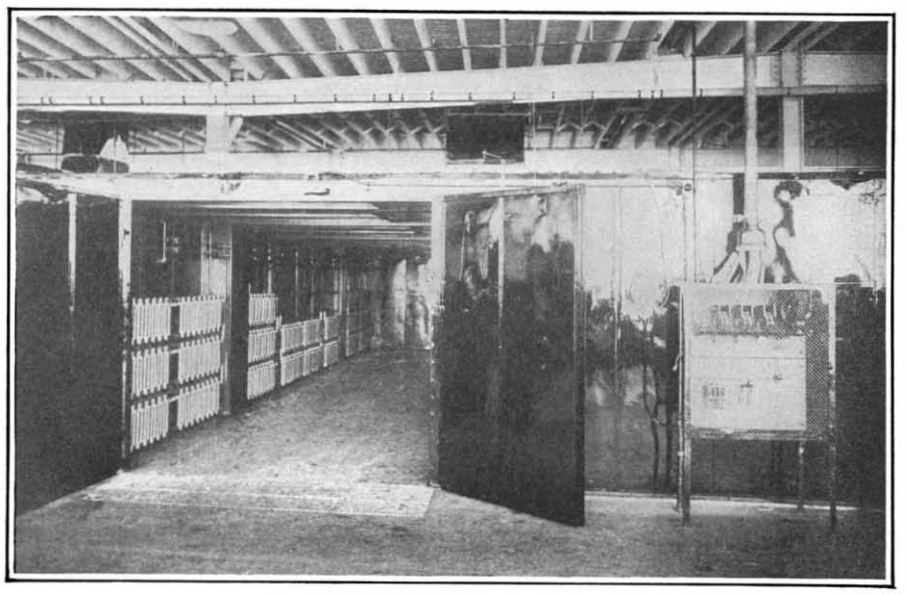
Wood Block Flooring for Factories.— The advantages of the wood-block flooring have been made available for shops and storehouses, by a recent invention which greatly simplifies the matter of laying it. The virtues of the wood block with the ends of the grain exposed to the wear and tear of service, have been recognized for a long time; but it has been found tedious to lay and therefore costly, as the pieces had to be placed separately. In the new invention, however, the pieces are secured to a foundation by dovetailing, and the flooring is laid in strips in much the same manner as ordinary boards. The individual blocks are of yellow pine with the ends up, measuring 1½ by 3½ inches, and 1 or 2 inches thick, according to the character of the intended service. The advantages of the wood-block flooring are durability, resiliency, dryness and silence.

A Shingle That Resists Exposure to Flame.—The shingle industry has been hard hit recently by legislation in various localities, which bars this roofing from the fire limits. In consequence, efforts have been made to arrive at some method of treating the shingle to reduce the fire risk and to restore it to its old-time popularity. Some tests were recently made at the University of Iowa, which seem to indicate that the desired goal has been arrived at. Arthur Brend of Badger, Iowa, formerly a student at the university, has compounded a solution which was under test. A piece of wood ½-inch thick was saturated with it, and after being immersed in running water for forty-eight hours, was dried and submitted to the action of the flame from a bunsen burner. After an hour the wood was unaffected except for a slight charring at the point of contact. The temperature of the flame was between 700 and 1000 degrees F., a much higher temperature than would be experienced in a conflagration. Mercury salts which have been used for the purpose are so costly as to make their use almost prohibitive, and zinc chloride washes out after exposure to the weather; but the new solution is said to have none of these disadvantages.

The Electrical Detection of Mine Gas.—An electrical apparatus for detecting the presence of mine gas, developed by C. M. Means of Pittsburgh, is so delicate in its operation that methane in the air in quantities as low as 0.5 per cent is instantly discernible; but the most practical form of the invention is intended to indicate the presence of 2 per cent or more of gas, as this is adequate for all ordinary purposes. The apparatus has been designed to meet the demand made by the increasing use of self-contained electrical portable lamps in the coal mines, as with them the miner is without the means of arriving at any determination of the character of the air in which he is working. The device is supplied with two glowers side by side and enclosed in gauze and glass. By pressing a button the current from a battery causes these glowers to heat to a dull red. In air containing no inflammable gases these are of the same color, but with a small proportion of methane or other inflammable gases in the air, one of the glowers will increase in temperature and luminosity, while the other will show a decrease. The glowers are properly guarded so that there is no danger attendant upon the use of the detector.



Installation of 350 electrically-heated jacketless glue pots



Electrically-heated japan-baking ovens in an automobile factory

Electric Heating in the Industries

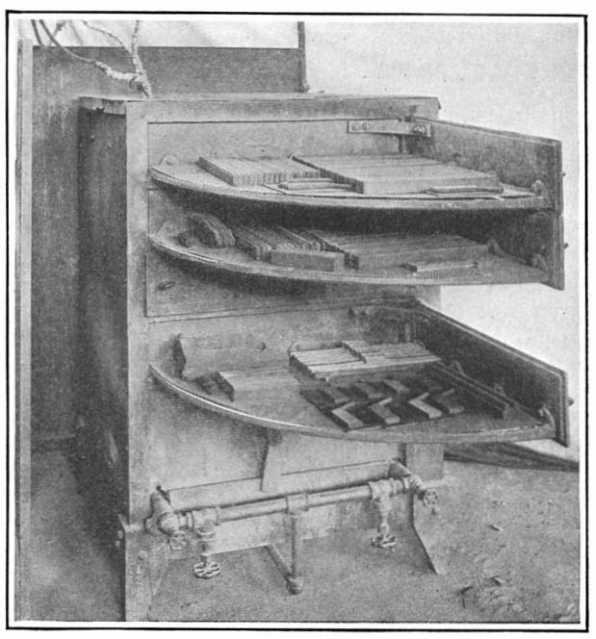
A Constantly and Rapidly Growing Field for the Application of Electricity

THE past year or two has demonstrated conclusively that there are numerous manufacturing operations where electric heating, despite its high initial cost and after taking every factor into consideration, is the most satisfactory agency in carrying out certain important heat-treating processes.

If the applicability of electric heating were to be judged solely by its initial cost as compared to other forms of heating, it would seldom survive the first phase of an analysis; indeed, there would be no analysis, for the cost would be an item immediately apparent. Such is not the case, however, for it is now a recognized practice not to consider the relative cost of electricity and gas, oil, coal, and other fuels, in passing upon the applicability of electric heating. There are other factors of far greater importance which must be considered, such as the improvement in quality of work; rate of doing the work, that is to say, increased production; reduction in floor space occupied by equipment; ease of handling the work; reduction of fire and explosion hazards; improvement in sanitary conditions; elimination of transportation and storage of coal, oil, gas, and other fuels; and similar considerations.

Electric heating can rarely be standardized for each industry as a whole; each application must be considered as a separate problem, lest electric current be misapplied in heating operations and thereby retard what is regarded as the most promising load builder for central stations. Even the limited number of industrial heating devices which can be considered commercially standardized, offer opportunities to add greatly to the connected load of the power companies; and such applications as the baking of japan, foundry cores, and bread; drying paints and insulation materials; melting wax, brass, and white metals; boiling varnishes; heating glue, soldering irons, etc.; and sherardizing metal, offer extensive fields for the exploitation of electric heating and the taking of load which, in a great many instances, is for the off-peak period which every power company is anxious to fill out.

Typical of the many forms of electric heating are the new japanning ovens, core ovens, bread ovens, the melting of brass, and sherardizing. Of late, notable progress has been made in applying electricity to the baking of japan, and in one plant alone some 20,000 kilowatts of current are used for this purpose, while in another company ovens are being installed of 15,000 to 20,000 kilowatts capacity. Still another manufacturer



Electric core-baking oven

is using about 3,500 kilowatts; and numerous installations have lately appeared, ranging anywhere from 50 to 250 kilowatts per equipment. It is said that to-day there is a total of at least 51 companies using electricity for baking japan, representing in the aggregate a connected load of about 45,000 kilowatts.

Some progress has been made in equipping core-baking ovens with electric heating apparatus, and the results are said to promise much for the future. The writer's attention has been directed to an oven for baking cores used in the manufacture of small brass and copper castings, where certain portions of a given casting are of considerable thickness while other portions are quite thin. Such cores, obviously, are difficult to bake properly, especially if the temperature is not maintained at the correct value; for incorrect temperature may cause the thin portion to be overbaked, while the thick portion may be underbaked. Before the particular oven in question was changed, there was a large loss of cores due to the difficulty of maintaining an even temperature; but since the oven has been electrified the operator reports that not a single core has been lost. And, while better castings are now obtained, there is a saving in time ranging from 25 to 30 per cent in the baking process. On the other hand, where cores are of large dimension and the castings need not be accurate as regards sharply defined edges and faces, electric current may not always offer sufficient advantages to warrant its employment.

In the baking of bread and pastry there appears to be more promise in the future than in the past, for this field of electric heating has been rather slow in developing. This may be due to the fact that the characteristics of electric heating, particularly uniform temperature, are not as essential to successful baking as they are to other industries. However, the cleanliness of electricity should do much to further its use in the bakery in those regions where the cost of current is not excessive; and many central stations are striving hard to introduce electric ovens in the bakeries in their territory, since it would mean a large connected load.

Electric heating is applicable to low-temperature operations as well as to those of high temperature of an order sufficient to melt steel. Examples of the former kind are to be found in heaters which have been developed for low temperature applications. These heaters are made up by mounting a number of units on a metal frame, each unit consisting of a thin metal

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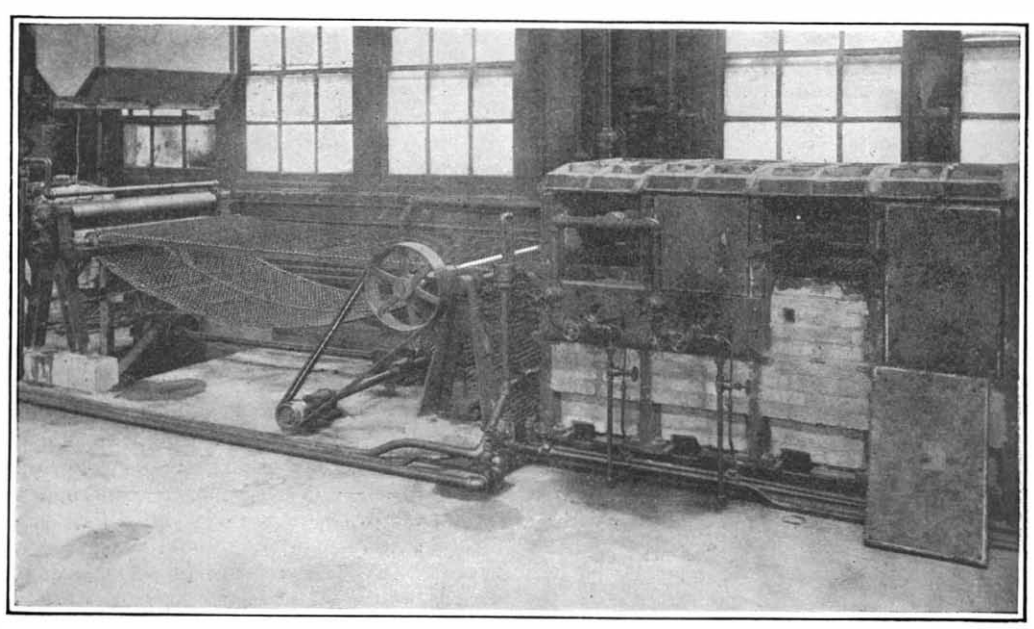
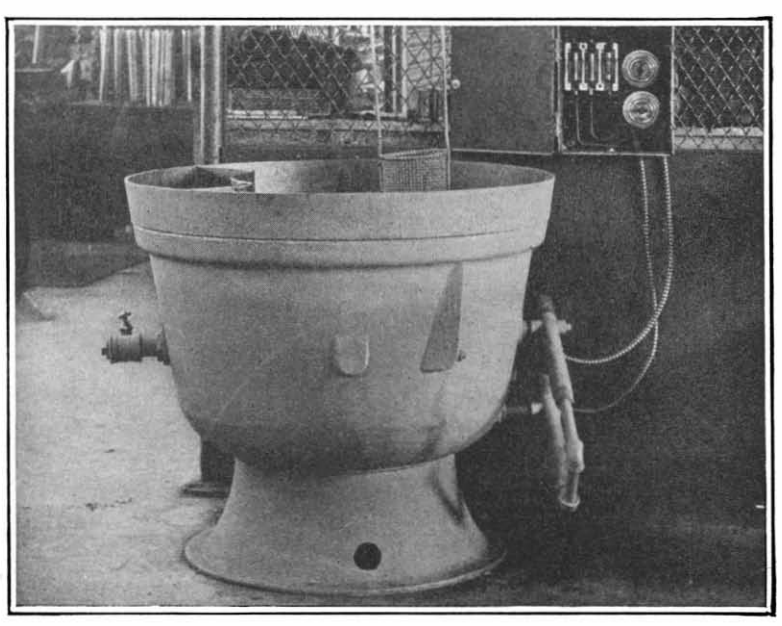


An enameling furnace using electrical heat, employed for small parts

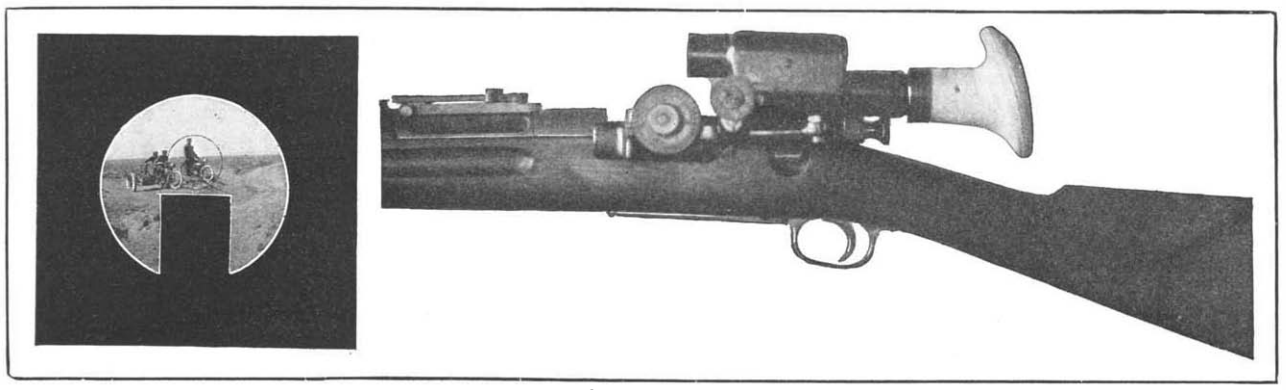


Sixty-gallon potash kettle equipped with circulation heaters

The Telescopic Rifle Sight in the United States Army

WHATEVER the shortcomings of the United States in the way of preparedness, it was one of the first to develop a telescopic sight specially designed for use on a military rifle. Such sights have of course been used for years on target rifles and occasionally in military service, but even those intended for use on sporting rifles were hardly suited to the rough use and exposure incident to active service.

In addition to its employment on machine guns for long-range firing, the telescopic sight is intended for the use of trained riflemen, who have the skill to take advantage of its superior optical powers. Those issued to each company are added to the equipment of the soldiers who have shown themselves most proficient with the rifle in target practice and in war these men would act as snipers when required.



View through an ordinary peep-sight

U. S. Army telescopic sight mounted on the service rifle

So far as known no country has contemplated equipping every rifleman with such a sight, for the very practical reason that the majority of soldiers would not have the skill to use it and that the opportunities for use are more or less limited. It is a very fair rifleman who can hit a man at 500 yards and at that range a man is quite a visible target to the naked eye unless carefully concealed. A larger target can of course be hit by the same man at a longer range but the visibility is also increased on account of the size. In other words ability to see with the unaided eye and ability to hold the rifle steady enough to hit are about equal with the average man even after a good deal of training; and ability to see is far ahead of ability to hit in the case of a poorly trained man. It is the man who has so great skill with the rifle that he is handicapped by the limitations of unaided sight for whom the telescopic sight is intended.

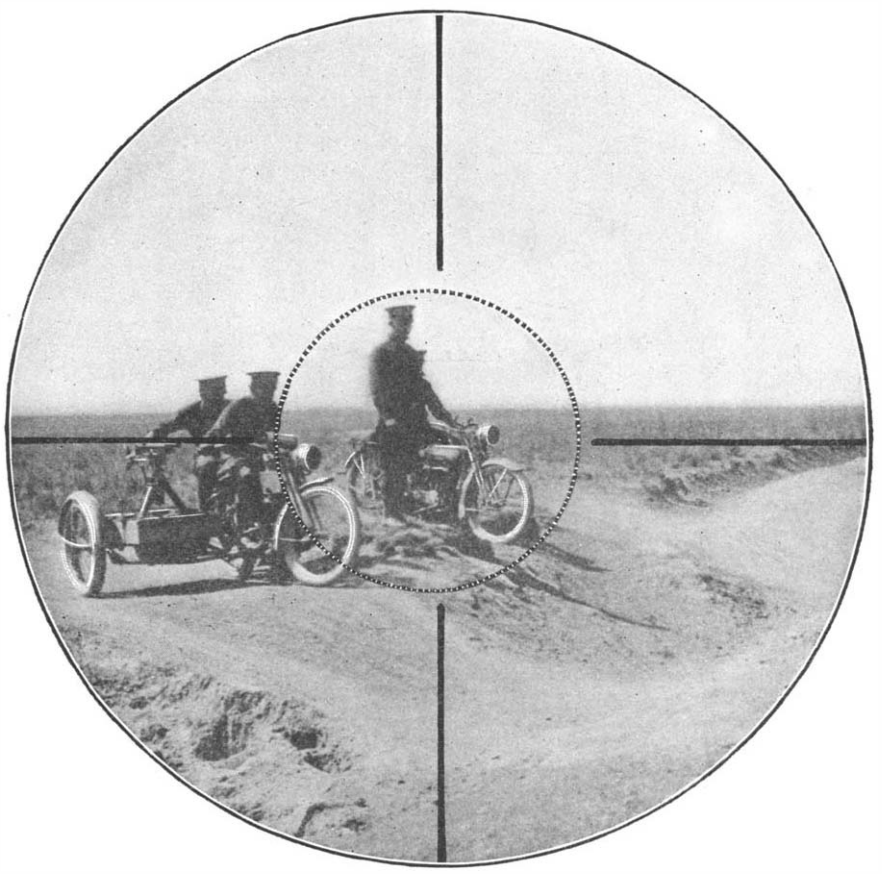
We illustrate the sight adopted by the United States Army, mounted on a service rifle. It has a dovetailed slot that slips over a corresponding piece fastened to the breech of the rifle and is held in place by a catch, the whole device being readily removable so that it can be carried in a leather pouch for protection when not required.

This telescopic sight has a magnifying power of six diameters. What this means is graphically demonstrated by our two views. The small square view shows the field of vision through the ordinary peep sight, with the marksman aiming at a motor-cyclist 500 yards away. He moves his gun about until his target appears in the center of the aperture afforded by the peep and just clear of the rectangular projection of the foresight. Then he pulls the trigger.

In the larger, circular view the same field shown in the small picture appears as seen through the telescopic sight. Here the object of the shooter is to make his target fall upon the intersection of the cross-hairs. In both cases, of course, the dotted circle is an embellishment of our artist, to attract the attention of the reader's eye to the actual target as distinguished from the rest of the scenery; it does not form part of the field of vision as seen by the sharpshooter.

The optical features of the telescopic sight differ from those of the ordinary telescope principally in that the length is made as short as possible by the use of prisms which so reflect the rays of light that they pass from end to end of the rather square body instead of only once down a relatively long tube. Every effort is made to make the instrument dust- and moisture-proof, and a rubber eyepiece is provided to protect the eye so far as possible from the recoil of the gun.

The sight is set for range by turning the large milled disc at the front of the sight which is graduated up to 3,000 yards. Turning this disc operates a cam which in turn rotates the telescope up and down with respect to the bore of the rifle. Corrections for direction are made by turning the smaller milled disc which rotates the telescope from side to side. The rifle is aimed when the sight is correctly set and the rifle so pointed that the target appears at the intersection of horizontal and vertical lines in the telescope similar to those of a surveyor's transit. On top of the sight there is a table of useful information relating to the setting of the sight under various conditions.



The same view as that above, but seen through the telescopic sight

Ruth Law and Her Remarkable Flight from Chicago to New York

IT was while the interest in Victor Carlstrom's recent flight from Chicago to New York was at its height that Miss Law, an exhibition flier of note, announced her intention of duplicating the feat. Although she was known to be a skilled aviatrice, her announcement did not carry much weight in aviation circles. For one thing, such a flight of over 800 miles at this time of the year called for the most hardy coustitution to withstand the intense cold and the sustained nervous strain; secondly, the only machine at her command was an old Curtiss "pusher" biplane which, at the best, was only suitable for short, exhibition flights. "Impossible" was the sum of the opinions of aeronautical experts.

Yet Miss Law has accomplished the "impossible." On Sunday morning, November 19th, she left Chicago in her antiquated Curtiss biplane and flew without stop until she reached the race-track at Hornell, N. Y., with her fuel exhausted after having covered a distance of 590 miles in 5 hours 45 minutes. Replenishing her fuel tanks Miss Ruth Law again took to the air and covered the 90 miles to Binghamton, N. Y., in about 56 minutes. The following day, Monday, Miss Law left Binghamton at 7:23 o'clock in the morning and alighted at Governors Island, New York city, at 9:37.35 o'clock, having covered this portion of her journey in 2 hours 15 minutes for the 152 miles, bringing the total time for the 832-mile flight up to 9 hours 1 minute.

Victor Carlstrom held the American cross-country record prior to Miss Law's flight, having flown in his large Curtiss biplane from Chicago to Erie, Pa., in 3 hours 57 minutes. Had a small coupling, which attached the gasoline to the carburetor, not become loose, he would in all probabilities have reached New York city on the same day as he started, namely, November 2nd. When the coupling became loose, however, much gasoline was wasted before alighting and the delay in obtaining sufficient quantity of fuel eliminated Carlstrom's chance of reaching his destination before dark. The gas line parting was the only trouble encountered, although the machine was flying in a stiff wind and carrying a gross weight of 4,300 pounds. As it was, Carlstrom's longest flight, from Chicago to Erie, Pa., was eclipsed by Miss Law's flight from Chicago to Hornell, N. Y., a distance greater by 138 miles.

A comparison of the respective mounts of Carlstrom and Miss Law is most interesting. On the one hand we

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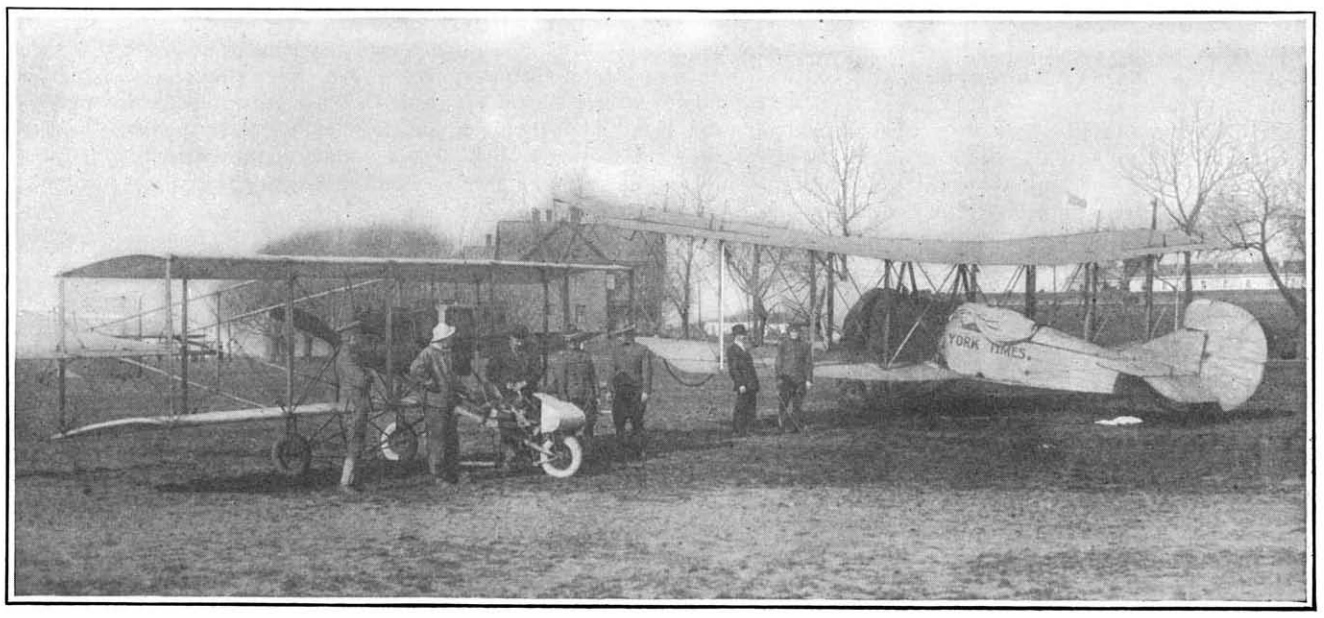
Photos. Copyrighted American Press Assn.

Miss Ruth Law at the lever of her record-breaking machine



The antiquated pusher-type biplane flown by Miss Law alongside of the huge military tractor-biplane employed by Victor Carlstrom

Strategic Moves of the War, November 22nd, 1916

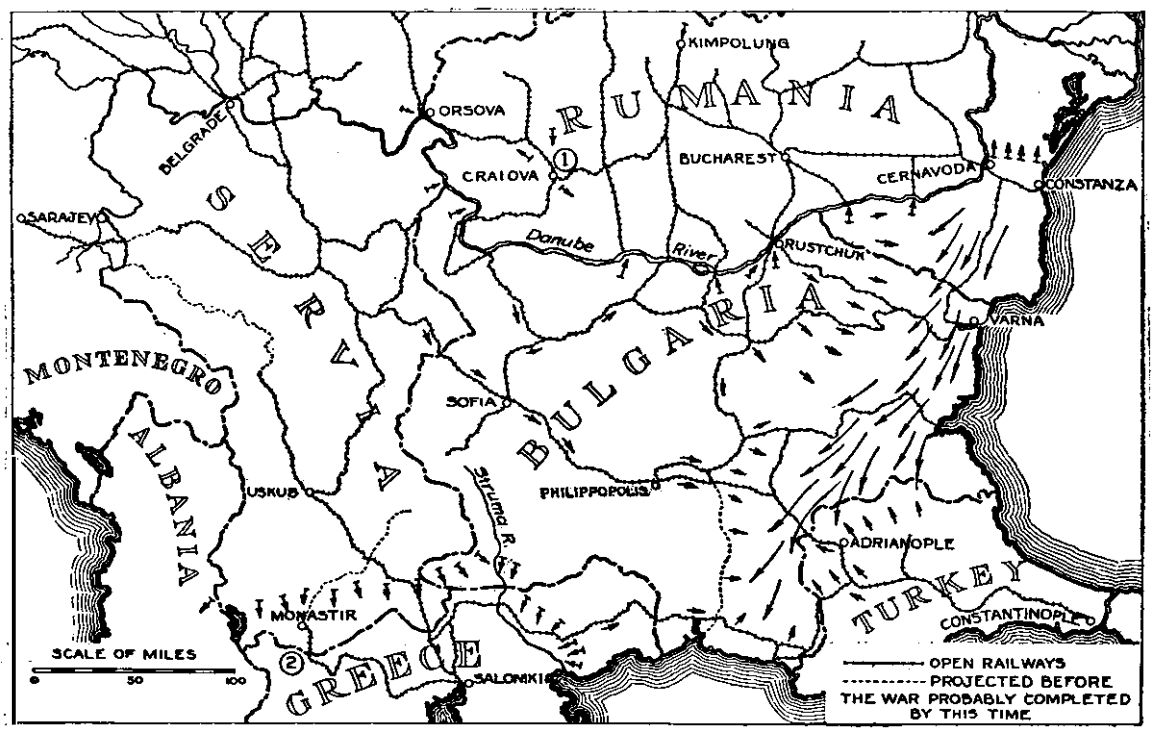
By Our Military Expert

THE Balkan situation positively refuses to give up the spot light and to retire from the center of the stage. Just when we were settling down and getting used to reading how Somme lines were being "smashed" back and forth and their respective defenders hurled out of their trenches, thus giving a British Chaplain the opportunity to capture, single handed, 400 German prisoners (there seems to be no limitation to the possibilities of a British Chaplain or to the imagination of some "observers"), we are compelled to concentrate our attention on a series of bold headlines announcing the capture of Monastir by the Serbian army assisted by French artillery and infantry, and predicting all sorts of wonderful developments in the general military situation, from the salvation of Rumania and the restoration of Serbia to the capture of Constantinople and the beginning of the end. Let us be calm!

The capture of Monastir at this time is a gratifying success for the Allies in general and for the Serbo-Franco-Russian troops in particular. To the military observer, however, the principal value of this event is based on the possibility that it may be an indication of the existence of certain conditions, suspected but not generally known, and on its probable relation to the general situation in the Balkans.

The reader will remember that the capture of Monastir was not the result of a recently organized "drive." There has been more determination and push in the operations of the past week or ten days, but fighting of a more or less desultory character has been going on for months. The Serbs were doing most of this fighting. There were a number of good reasons for this.

The Serbian army, variously estimated at from 100,000 to 160,000 men, had been recently reorganized. While the details of this reorganization are not at hand, it is safe to assume that the army was composed principally of infantry. This army had to be occupied. The Serbs have no love for the Bulgars, so the Serbian army was permitted to get in touch with the Bulgo-German forces occupying the line south of Monastir. It was well understood that with Monastir in the foreground and their homeland in the more distant view, the Serbs could be counted on to stick to the job and keep the Teutons busy, but it was equally certain that without artillery and other auxiliary troops, the Serbs could not get very far away from Saloniki and thereby compel General Sarrail to pull them back or take measures to protect a lengthening line of communication from the Serb's advance line to the base at Saloniki. The first proposition would have had a disastrous effect on the morale of the Serbs; the second was practically out of the question owing to the political situation in Greece.



The war in the Balkans

While this map actually shows a number of points of interest at this time, it is especially intended to illustrate the difficulties that would be encountered by an army engaged in a "drive on Constantinople," should Russia be unwise enough to attempt one at this time.

The long arrows indicate the probable line of advance, the short arrows the many points where resistance would be offered continuously, and that would have to be met by the advancing force in addition to the frontal resistance (not shown on the map, except at the start, Cernavoda-Constanza line) that must be overcome or thrust aside to permit the advance to proceed towards the objective.

The short arrows with cross-bar indicate the present points of attack of the Central Powers.

1. Craiova, reported (November 21, 1916) occupied by the Austro-German armies.
2. Monastir, recently *taken* by the Serbo-Franco-Russian troops.

The military conditions that demanded a strong offensive from Saloniki to the north made it imperative, as long as that was impracticable, to do the next best thing; and this was to prevent the Central Powers from withdrawing too many troops from the forces in front of the Allied lines north of Saloniki and using them in Transylvania and elsewhere. Hence the constant pecking at the Bulgo-German lines by the Serbs in the Taherna (Cerna) river section and by the British in the Struma or Karatsu river section. Until about a week or ten days ago no special determination or definite purpose was apparent in either section. The French troops not occupied in the Vardar river section, where there was little or no active operations, were evidently kept in reserve, well in rear of the line.

About eight or ten days ago, we began to receive reports intending to convey the impression that the relations between the Greek Government and the Allies were improving. We were told that the King was anxious to impress upon the people of Greece the fact that he was then in sympathy with the Allies. We read also that the Allies had been quietly taking charge of the fleet as well as of the greater part of the arms and military supplies in excess of what was actually necessary to equip a comparatively small fraction of Greece's regular army. We were told also that the Venizelos movement was gaining in strength and that large numbers of Greek volunteers had organized and joined the Allies in Saloniki.

It was about this time that we first heard of French artillery and "a few battalions of French infantry," probably artillery supports, being engaged in what appeared, for the first time, to be a serious advance against Monastir.

This means either one of two things, possibly both. Either the Allies discovered that the Bulgo-German line south of Monastir had been so weakened, by removal of troops to other fronts, as to give promise of success to a prompt and determined offensive; or else the Allies are getting the Greek situation sufficiently in hand no longer to fear the undue lengthening of their lines of communication by an advance toward the north. Both conditions are possible and quite probable. We can only guess at the answer, but without knowledge of the conditions and in view of the fact that the Allies have been striving hard and earnestly for the control of the Greek situation, it is fair to assume that they are progressing and will eventually succeed. This success may be an accomplished fact before these lines appear in print. We also know that in spite of the Central Powers' vast resources in men and supplies, they are beginning to feel the strain quite seriously, specially since Rumania's entrance into the war, hence the tremendous and almost irresistible efforts made to crush Rumania from the north and the apparent loss of offensive power reported from all other fronts including the north of Saloniki line. This may account, in part, for the Allies' success in the Cerna river sector.

Monastir has little or no military value. It is a liability rather than an asset. It must be defended from a distance, therefore, it requires a forward movement to the north and northeast, in considerable strength and with rapidity, to give lasting effect to the present success. This movement should begin without delay, but it will not be undertaken unless the political situation in Saloniki warrants it.

It is too early to say just what effect a successful advance in force to the north of Monastir would have on the effectiveness of Falkenhayn's offensive, but from the manner in which this offensive has been conducted it is clear to me that the German General Staff considers this movement to be paramount to all others. So I feel quite sure that neither troops nor supplies will be diverted from Falkenhayn's armies until Bucharest has been taken or . . . the unexpected has happened!

It is evident that at this particular stage of the game, the Central Powers can afford to lose almost anything that the Allies are likely to be able to gain in southern Serbia during the next eight or ten days. By that time, something of a decisive nature should happen on the Transylvania front.

In the meantime the situation in Wallachia is daily growing more and more serious. The recent Russo-Rumanian offensive in the Dobrudja apparently failed to relieve the pressure on Rumania's northern lines; as a matter of fact there is no good military reason why it should have been expected to affect these lines except in an indirect way. As I have pointed out last week, nothing is to be gained by a so called "drive" down the Dobrudja at this time, and Mackensen should be pushed and held a few miles south of the Cernavoda-Constanza line, simply because it would be easier and more advantageous to the Russo-Rumanians, on account of the Cernavoda bridge over the Danube at that point, to hold him there than further north or further south. No other operations should be attempted in that section until Falkenhayn has been driven out of Wallachia and beyond the Carpathians. When this has been accomplished, a sufficient force of all arms should be posted on this frontier to guard all the mountain passes and prevent a repetition of the present invasion; *then*, but not until *then*, may the Dobrudja advance be resumed with some hope of success. Its first objective should be Sofia, and into this movement should be placed every man and gun that can be spared from northern Rumania and from the Russian fronts. At date of writing, the Austro-German troops are reported to have taken Craiova in western Wallachia. Failure of the Rumanian army to hold Falkenhayn in the north is also admitted in bulletins from Petrograd.

I am unable to understand the present attitude of Russia with reference to Rumania's danger. It is barely possible that Rumania is being punished for being headstrong and disobedient and for showing her contempt for the advice of her great Allies by invading Transylvania. But her punishment, if such it is, has been sufficiently severe. There must be other reasons for Russia's apparent inactivity.

We have had no bulletins from the Dobrudja for about a week, and there has been no report of unusual activity on the Russian front for about the same period. Could it be possible that Russia is preparing another surprise for us as well as for Falkenhayn? We should know within the next ten days.

It has been said repeatedly that Russia was preparing for a great drive in the direction of Constantinople and a number of writers on military events thought that the recent "drive" against Mackensen was but the prelude to this movement. Mackensen was not "hurled" out of the Dobrudja as rapidly as was expected and very little more was heard about the matter until the report of the capture of Monastir was received, then the old idea again came to the front and it was stated that this success would probably have some influence in hastening the Russian drive for the capture of Constantinople. I would say without hesitation that this influence would be so remote as to be not worth considering at this time, but as the statement has been made repeatedly, it is thought that a brief discussion of the possibilities of such a movement may be of interest to the reader.

Let us glance at the accompanying map to get a general idea of the lay of the country and then consider the distances and natural obstacles. Adrianople is the first natural objective of a "drive" on Constantinople from either the north, the northwest or the west; the

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Industrial Preparedness for Peace

Personal Experiences During the Industrial Upheaval That Followed the Outbreak of the War

An Interview with Thomas Alva Edison

Our national reputation for resourcefulness was put to a severe test when the European nations plunged into war, two years ago. We were confronted by an industrial situation we had never dreamed possible. Suddenly deprived of materials and products unobtainable elsewhere, we were obliged to exert our utmost ingenuity and enterprise to keep our industries going and supply the demands of our own people, as well as those of nations even less favorably situated than we. How our financiers and manufacturers arose to the occasion, how we have been liberated from slavish dependence upon European industries, has been told on many an occasion. Nevertheless, we believe that the public will be interested in the personal experiences of America's most widely known inventor. In a recent interview with a member of our staff Mr. Edison told the story of his problems and accomplishments during the trying months of isolation from Europe. He had also something to say about the necessity of gathering nitrogen from the atmosphere and fixing it in compounds that it may be used for the defense of our country, for the needs of our industries, and for the fertilizing of exhausted farm lands. In the interview as here published we have omitted our questions in order to present an uninterrupted narrative.—Editor.

THE war affected us very badly. In the first place we used to be one of the largest importers of carbolic acid, which we use in making our phonograph records. I had a supply sufficient to last two months and a half when an embargo was put on it. I had a boat-load ready to ship, consisting of 100,000 pounds, which they took off the vessel at England and would not forward. This meant that we would have to shut down the phonograph plant. So I started in and tried all the processes that were recorded. In about three weeks I had them all tried out and was ready to undertake manufacturing on a commercial scale.

Then I tried to purchase benzol, but was unsuccessful. I made application to a large steel plant offering to put up a benzol plant myself, but they would not listen to me although I offered to rent a small section of their property, make the whole thing myself and pay them 18 cents per gallon. They would incur no expense and I would be paying them for what they were throwing away, but their Board of Directors would not permit me to do this. Then I put up the proposition to a steel company in Johnstown, Pa., and it was accepted. In 45 days I was turning out benzol, but I did not get enough. I approached everybody in the United States, but without success, except in the case of a company at Woodward, Ala. They said, "It looks good to us. We cannot lose by this proposition. Go ahead." I had this plant up in 60 days. Then I decided to send up to Canada. They said, "All right, you furnish the plans and we will do the thing ourselves." I furnished them with plans and that fixed that, all right.

There were two or three other things with an embargo on them. We were getting short of wood pulp which we use in our phonograph records. I succeeded in finding a place where this material could be made for me. I had a great deal of trouble in getting diamonds for our phonographs, there being an embargo on them also.

Then we made anilines from benzol. Some of my coöperators in the rubber business wanted me to help them out in the manufacture of anilines. Some of the printing works also appealed to me for help. So I started to put up an aniline plant and had it finished about five months after the war began. I was the earliest one in the business and the plant has been running ever since.

Then there came an appeal from the fur dyers. They could not get a pound of what is called paratphenylene-diamine. They wanted to know if I could make that for them. I put up a plant and furnished all the dye for them. Then they wanted aniline salt, so I put up a plant for that as well.

Photographic supply houses experienced a great famine of para-amidol-phenol, which is used for the developing of plates. Everybody was short of this chemical, so I put up a plant for it too. Now I am putting up a plant for making benzidine, which is almost ready. But I am going to quit making any more plants, for I doubt that I can keep in after the war is over. All these plants were put up to meet an emergency. Nearly every plant was built in 60 days.

We have reached a measure of industrial independence since we have been forced to make things for ourselves, but we will never become entirely independent in the manufacture of dyes. Germany can make them better and cheaper than we can and we should buy them from Germany. What is the use of our wasting our time to make things that Germany can make at lower cost? We should devote our time to other things that we can make cheaper than Germany can. We will probably hold our common dyes, but I am very doubtful about holding the complicated dyes. Germany has been at work upon them for so long that we cannot expect to compete with her.

It is not probable that we shall ever be trapped again as we were this time. If we have about 25 or 30 colors or shades manufactured in this country they should meet all the requirements of any normal being. There is no necessity of our manufacturing 1,657 different shades of color. We have too much to do here without competing with Germany in that field.

It is too bad that we did not make our own benzol and aniline in this country, instead of importing it, when we are throwing away coal by the thousands of tons every day. We are very wasteful in our mining methods. We mine only the coal of a grade that returns a good profit. All the rest is discarded, because we have no laws which will prevent the hundreds of millions of tons from going to waste. We even let natural gas blow off just for the amusement of the public. We have no laws to stop such wasteful procedure. There should be no difficulty in regulating the matter by law. Why they even go to work and pass laws in Minnesota to regulate the length and dimensions of sheets on a hotel bed? Why then can't something be done to prevent the robbing of our country's natural resources?

One of the most important things that should be started in this country is the manufacture of nitrogen. The matter should be agitated. I do not believe that the Government itself should undertake to build and operate a plant for the fixation of nitrogen, but the Government ought to assist by providing individuals with credit or otherwise. We are approaching the age of the verge of land exhaustion. We will have to go into intensive farming and must have nitrogen. We can make it economically here, just as economically and far more so than in Germany, because we have more water power and our coal does not cost as much. All the raw materials cost less here. Then, too, Americans have a way of blundering into high efficiency. Take for instance, our low-priced automobiles, they are something that Europe cannot understand. We pay more for labor, but an American laborer is worth more than a foreign laborer. I have timed different nationalities at a certain operation that required a little intelligence, and the result is surprising. I think one of the best measures of people is the number of looms that a man can attend. In China I believe a man has all he can do to attend to a single loom. America stands ahead in the number of looms a man can handle and produce the same quality of goods. I believe we stand 40 per cent higher than any other country. Psychologists would do well to study the mental equations of different countries. When I went through Europe I took the personal equations of the men. In France they were quicker to pay attention to my automobile horn than in any other country. In Switzerland you could nearly run a man down before he heard the horn. It represents the peculiar mental state of the people. For instance, I had a factory in Berlin for making phonographs, one in Antwerp and one in London. The highest efficiency production with the same conditions was in Antwerp and the lowest in Great Britain.

I think that the most successful method of producing nitrogen is that known as the Hauser process. It is the passing of nitrogen and hydrogen over incandescent, finely-divided iron. This makes ammonia and from this fertilizer may be manufactured. However, the best way of making nitrogen has not yet been discovered. Several years ago in experimenting with my battery, the whole laboratory got full of a substance that smelt like ammonia, although it did not have exactly the right smell. However, I never followed that up.

The best way of making nitrogen has not yet been found, but no doubt the proper trick will be discovered. It is of enormous importance—gigantic!

The Current Supplement

AN important article in the current issue of the Scientific American Supplement, No. 2135, for December 2nd, 1916, is *Roentgen Rays and Crystal Structure*, which is a study of how atoms are grouped in solids. Hydrogen gas is becoming important for various technical purposes, and this necessitates cheap production on a large scale. An article on *Electrolytic Hydrogen* describes one of the newer processes developed for the purpose, and it is accompanied by a number of descriptive illustrations. *Is Vegetarianism Based on Sound Science?* discusses theories and results that will be of value to a great many readers who are interested in dietary matters. *The Manufacture of Bottles* briefly touches on a product that is absolutely indispensable, but so common that no one gives it thought. It is illustrated by a number of excellent photographs taken in a large factory. *Allotropic Changes in Iron and Other Metals* treats of a new thermo-electric method of studying important structural changes that are as yet not clearly understood. *Proportional Drawing* is a demonstration and explanation of a number of geometrical problems that will be found most valuable to draughtsmen engaged in a variety of lines of work, and it is accompanied by a large number of diagrams. The article on *The United States Lighthouse Service* is concluded.

The Paint that Won't Come Off

TESTS of elaterite, otherwise known as elastic bitumen or mineral caoutchouc, refined and in liquid form, are disclosing this hydro-carbon, of which vast beds exist in eastern Utah, as an extremely useful agent in the world of industry rendering services that nothing in nature heretofore was known to perform. As brought into commercial form, in solution, it is used as a coating, or paint. When spread over surfaces of wood, iron, steel, leather, rubber, cork, concrete and tin the solvents evaporate, leaving an intensely close-grained, luminous, ebony-black veneer which is completely poreless. This coating is over 99 per cent pure carbon, and is acid-, alkali-, water-, electricity-, oxygen- and nitrogen-proof. It is serving with conspicuous efficiency as a coating for tanks and other containers for solutions used in galvanizing, the recovery of gold and silver from low-grade ores, electro-plating, pickle factories, and other industries wherein unprotected tank-surfaces are found to decay rapidly through contact with their permanent contents.

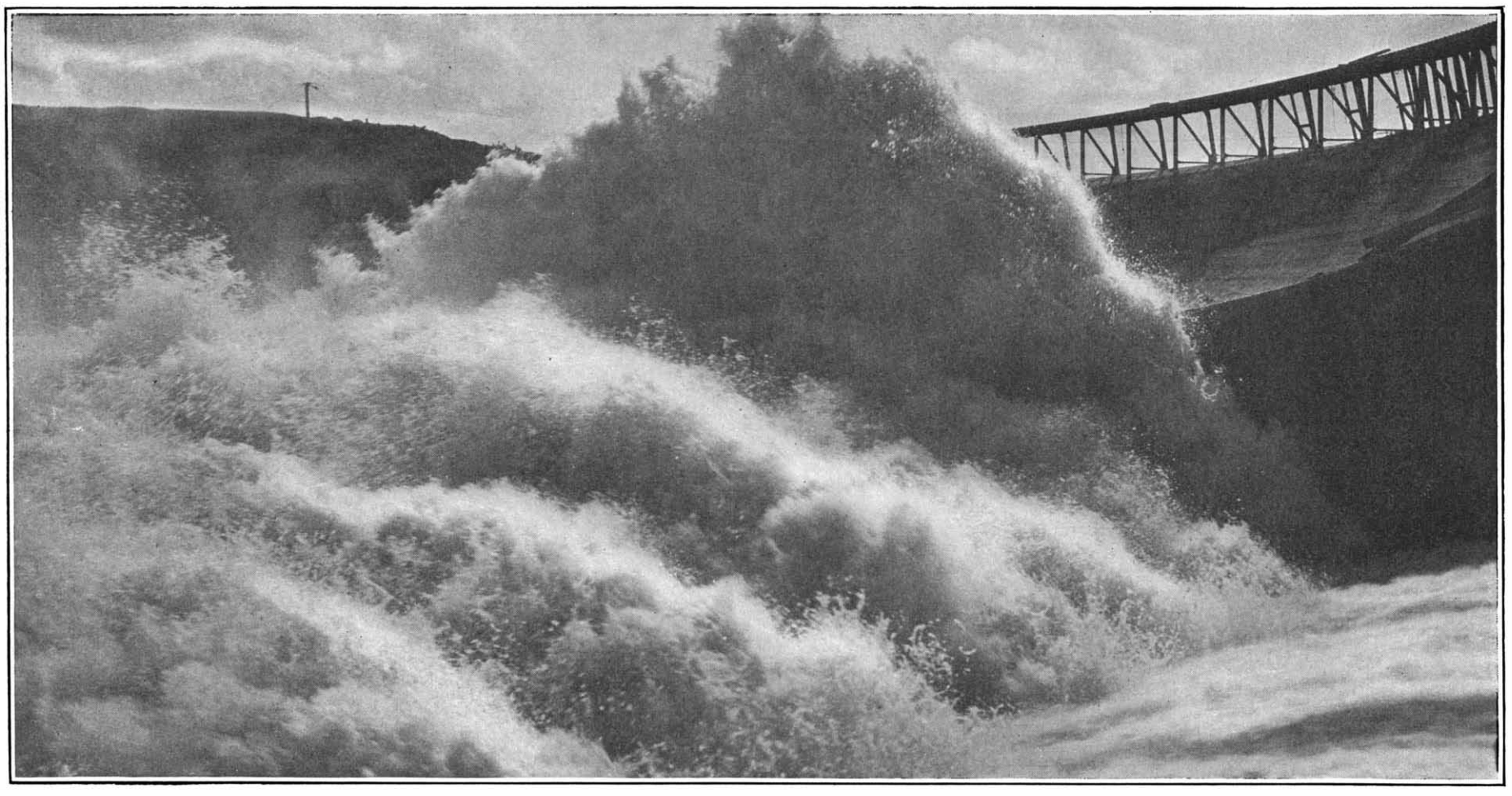
Experiments extending over the last four years have demonstrated that underground pipes of both wood and metal, when coated with elaterite solution, were not in the least affected by decomposing elements of the soil, complete prevention of rot and rust having been accomplished. In iron pipes and steel superstructure which were coated with elaterite solution electrolysis was completely frustrated. Telegraph and telephone poles and fence-posts, the lower ends of which had been immersed in elaterite solution before burial in the ground, were found to have remained sound and their elaterite covering was entirely unaffected by acids and alkalies of the soil. In its utility as a coating for marine craft, where lead-and-oil paints have had but brief lives, elaterite proves itself a permanent agent and a conspicuously successful protection to hulls from the deteriorating influences of fresh and salt water.

In the analysis of the secret of these unusual powers possessed by elaterite it is found that the refining process eliminates 11.19 per cent hydrogen, 4.78 per cent oxygen, .17 per cent nitrogen and .24 per cent sulphur contained in the characteristic crude product, after which contraction becomes so acute as to prohibit passage of water or air. The substance is itself impervious to water, oxygen, nitrogen and electricity, its chemical inertia being such that it is indestructible by any element in nature except intense heat.

The permeating of the elaterite solution into the minutest pores of substances to which it is applied constitutes a series of thread-like supports of the coating, hence it does not crack or peel. The qualities of the crude product, which have attached to it frequently the name of "mineral rubber," are retained and as a coating solution therefor it readily adjusts itself to gutta percha products effectively, preserving these from degeneration by both nitrogen and oxygen.

Elaterite solution performs similar service on leather, making a coating thereon which does not crack or peel, and imparting to such articles as automobile upholstery a permanent black gloss, water-proof and almost indestructible.

The formula under which elaterite solution is now being marketed is the first worked out permitting its commercial adoption. Previous attempts to put it in solution were accompanied by such high cost that its use industrially was prohibited. The only known elaterite deposits in the world, outside of Utah, are claimed by Austria, where the production possibilities are limited.



Twelve thousand second-feet of water hurtling through the waste gates at Rainbow Falls, Montana

Forty Million Horse Power Wasted

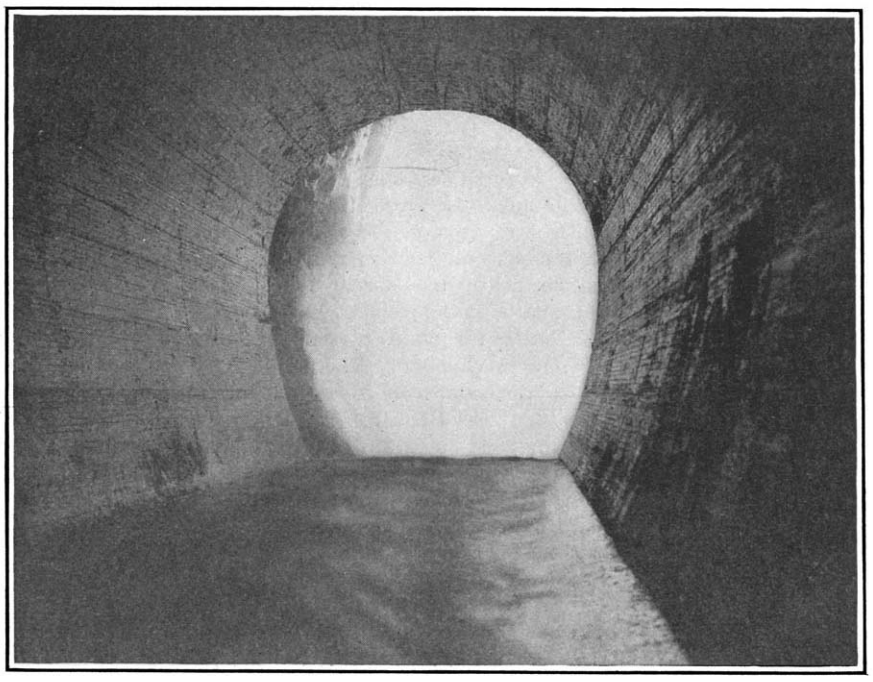
A Plea for the Utilization of Our Water Powers

By Hugh L. Cooper, Member of Amer. Soc. of Civil Engineers

IT has been reliably reported that two New England men are about to startle the world with an entirely new power supply. One of these gentlemen is said to be a consulting mechanical engineer, the other an astronomer, both in very good standing. The story is that these two gentlemen have gone so far in the realm of infinitive formula that they have been able to develop a method that will enable them to stop the earth at will for 1-32 of a second of time and to bottle up the energy necessary to stop the earth in its rotation for this interval, store the product so created and sell it commercially to the world. It is to be hoped that before the plan is actually put into commission two other gentlemen of equal abilities will be found who will be willing to collaborate with them to the end that the earth can be started promptly in its revolutions after it is once stopped, otherwise there will be a painful absence of market for this novel power.

The use of important space in the SCIENTIFIC AMERICAN in reciting the above is justified only because recently other gentlemen of equal distinction have made other suggestions in scientific and other publications for the production of power which are nearly as bad as the proposal above noted. Every engineering office of any magnitude is continually approached by would be geniuses seeking to upset the laws of nature and thereby create improvements believed to be commercially worth while. From time immemorial men have been active in trying to evolve methods that will relieve humanity from physical toil. The world-wide campaign for increased efficiency is in a large degree dependent upon this same desire to be relieved from physical labor and there is a demand everywhere for cheap power, which can, as everyone knows, be best supplied by water power.

Of all of the civilized countries in the world, America was the only one where hydro-electric power development was at a standstill when the war broke out, and it is at a standstill in America now and has been dwindling yearly for the last ten years. The reason for this condition will be found in the disagreeable word "ignorance." This ignorance has been fostered and increased for the last ten years by political enthusiasts trying to hobby ride themselves into public attention and public office by the use of the unfortunate propaganda that a water power trust was trying to rob the people of the undeveloped water powers of the country. This propaganda has, fortunately, about run its course and it is probable that before long the citizens of the United States will be awakened to the penalties always incident to a blind following of reckless slander of men who, because of the nature of their work, are necessarily engaged in developments calling for large sums of money.



Behind the falls, mouth of the tail race of the Toronto Power Co. at Niagara

The legislation recommended by the men engaged in water power work calls for three things:

1st. A fixed tenure of 50 years in lieu of a revocable permit that could be taken away at any time any politically ambitious Secretary of the Interior saw fit. It would indeed be a dishonest financier who would recommend to investors securities that would be founded upon such insecurity, and the insistence upon the revocable permit by the hobby riders as being fair should of itself be sufficient evidence of the unworthiness of these gentlemen to be beard. Some gullible people, when the revocable permit law was put into effect, tried to operate on a revocable permit, with the result that some of their permits were taken away from them over night without even a hearing.

2nd. That after the expiration of the 50 year period, if the Government and the power company shall fail to come to terms for an extension of the rights, the property shall be taken over by the Government on the basis of its then fair value, wherein the rights given by the Government were to be eliminated from fair value. Certainly the reader will agree that such a proposal is no more than fair.

3rd. That the public shall fix the rates at which power should be sold. This would seem to be fair also.

Yet legislation embodying the above suggestions has been the subject of loud attack by the ultra-conservationist colony.

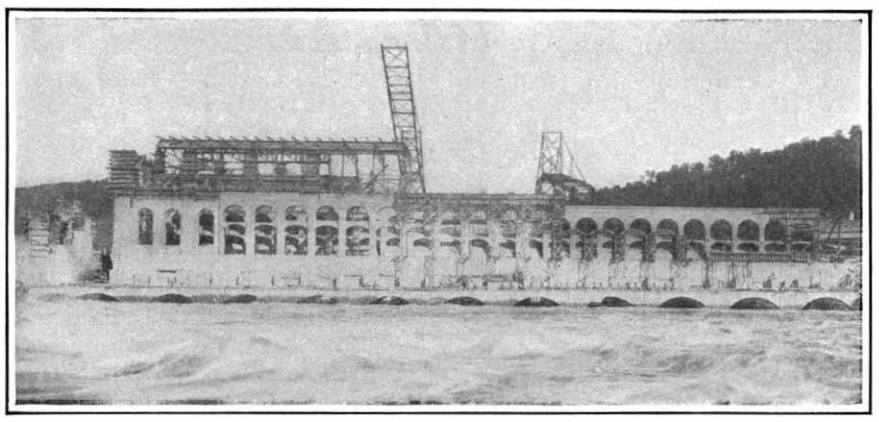
Manifestly the sole remedy for this situation will be found only in spreading the truth to every person who is interested in the development of the resources of their country and then calling upon the public in general for aid in the matter. Natural resources are the basis of every country's wealth.

Some years ago Lord Kelvin of England, who was renowned not only for his scientific attainments, but for his ability to correctly look into the future, made the prophecy that Canada, because of its vast natural wealth in water powers, would some day become one of the commanding countries of the world. The rapid development of water power in Canada and the resulting great increase in industrial wealth has strikingly confirmed Lord Kelvin's views.

It is claimed by Government officials that the United States has more than 40,000,000 horse-power of undeveloped water power within its boundaries. If this is true, it represents an amount of power corresponding to the amount of energy that would be derived from about 300,000,000 tons of coal worth about $600,000,000 a year in the boiler furnaces. To convert this vast amount of coal into energy would require about 600,000 more men than would be necessary for the production of the same amount of energy by water power. Every ton of coal that can be saved means more and better labor for the farmer, the railroads and the

manufacturer, also lower rates for transportation because of the amount of equipment that is now needlessly used in coal transportation, and means a reduction in the cost of power and a general set of benefits that would be enjoyed to a greater or less degree by every man, woman and child in the United States.

Outside of the question of cheaper power, the best industrial thought in the world to-day is ample authority for the statement that we are approaching, and in fact are already in, a new era in which chemistry is to play a most important and far reaching part. In a vast majority of the chemical operations electric heat is required at a price that coal cannot supply and unless we in the United States are prepared to say that we are quite willing for this great new era to be controlled entirely abroad, we must pass laws that will encourage the development of our water powers at home. The field of chemistry can be called upon to supply the needs of everyone in a multitude of useful ways, and the spectacle of a great country with 100,000,000 people allowing 40,000,000 horse-power to go to waste year after year is one we ought to be ashamed of.

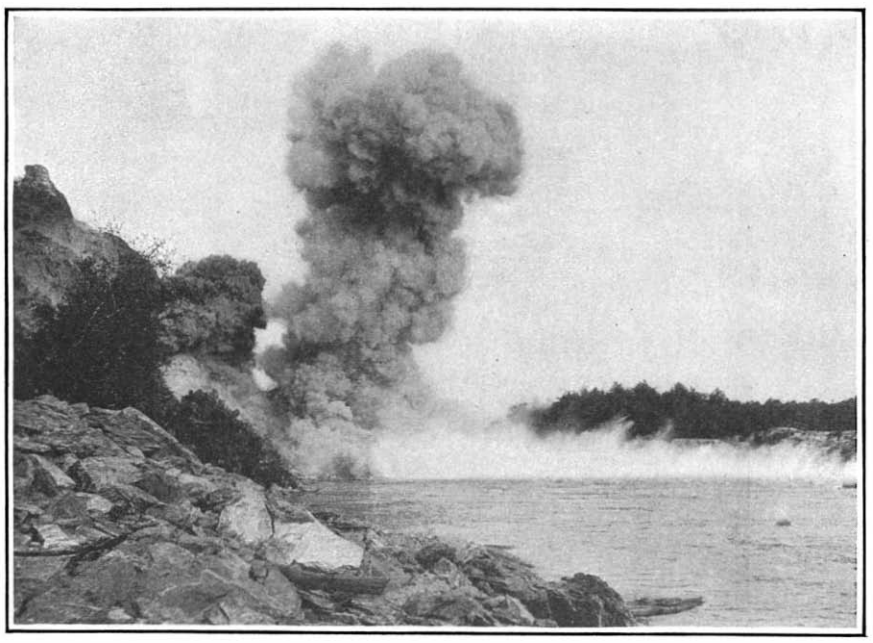


McCalls Ferry power plant on the Susquehanna during construction

It cannot be asserted that our inactivities in water power construction are chargeable to lack of either engineering brains or willing money. We have both in a well developed degree. Hydro-electric engineering in the United States, as far as engineering itself is concerned, has achieved actual results that show higher efficiencies from every standpoiut than has been accomplished eisewhere. The achievement of these efficiencies has followed the same rule of evolution that applies to every other form of human endeavor, and preceding the present day knowledge of hydro-electric work there have been a large number of financial disappointments involving hundreds of millions of dollars of investment. Yet in all of the discussion of this subject the hobby riders call these disappointments symptoms of a trust.

A few years ago I offered to wager a then prominent editor of a muckraking magazine $1,000 if he could show me one man in the United States that had ever made a million dollars out of water power. Wagering does not prove much as a rule, but in this case the muckraker declined the investigation with the statement, "I can sell magazines by attacking your business and I propose to do it." The foregoing statement is a fair sample of the honesty of 90 per cent of the attacks that have finally landed the water power business into its present state of complete inactivity.

If the question is asked, "Why does not Congress treat this matter as a non-partisan issue and come to the rescue of the situation," the answer is found almost wholly to lie within the unwillingness of the average Congressman to believe the testimony of people in the water power business or in any other business. The average Congressman is very desirous of doing what is right, whether he is a Democrat or a Republican, but he is naturally suspicious of every statement that any interested party makes on any subject. Some day, as a democratic form of government, we may have sufficient intelligence to provide in Washington some kind of a tribunal where any man desirous of undertaking a business in which the public is interested, may go and tell his story and have it stamped by impartial skilled judges with the percentage of truth that the statements made are entitled to, and in this way only will we ever get legislation that squares with facts. At present we as a people are so constituted that we read and remember sensational accusations much better than we read and remember worthy achievements of our builders. A recent campaign so successfully carried out by a very prominent magazine, holding up to view the splendid achievements of some of our greatest captains of industry, is an excellent move in a much needed direction. We have had a long muckraking campaign and the sooner we upbold and advertise the good men do, the better country we will have to live in.



An enormous blast at the site of the McCalls Ferry Dam

In conclusion, those engaged in the work of water power development fully realize that the passage of any law looking to the development of water power that is not absolutely fair to the public will be a useless law. Any law that Congress passes that does not deserve the honest confidence of the public at large will not serve to revive the industry. The investor will not be attracted to water power securities, with all of the hazards of construction, with public regulation of rates, with the past history of financial disappointments, plus a law that is suffering with the stigma of being dictated by greed, and no set of men are more alive to the necessity of the law being absolutely fair than the men who are engaged in the water power business itself. The accusations of the hobby riders to the effect that there is now or ever has been a water power trust, that there has been any grabbing and that the people have been in any danger in the past or future of being despoiled, have failed in every instance.

Just how long our population is willing to put up with the present situation in water power work is problematical. When the newspapers, through the increased cost of paper, and the farmers and manufacturers, through the increased cost of labor, and power consumers generally, through the increased cost of steam power, find all of their various power and labor costs becoming greater and greater each year, they will awaken to the folly that their previous inaction regarding their own interests has imposed upon themselves and demand of Congress fair and encouraging laws.

After the water power legal situation is satisfactorily disposed of there will be a very considerable hiatus before actual development can possibly take place. Hydro-electric power construction in the field must be preceded by an extensive amount of investigation to determine the feasibility of hydro-electric proposals. This exploration money must be provided by the promoter. Some philosopher has said that the world will never know what it owes to the unsatisfied man. The same philosopher might have made a similar acknowledgment regarding the promoter, for when we look, all the world over, at the great developments of the past now in commission for the betterment of mankind, we are certainly of prejudiced and little mind if we do not give to the promoter the credit that is his due. The larger the water power, the more funds are required for investigations preceding the decision as to whether the power is of any value. Until satisfactory and encouraging legislation is provided and a correspondingly encouraging attitude on the part of the investing public is developed the unjustly despised promoter will not be induced to seek out the possibilities and develop their value. Surely the good sense of our people will soon be awakened to the injustices, not only to themselves, but to the engineering profession, that have obtained in the past ten years, and will substitute for the past do-nothing record a program of sensible legislation that will give to all of our people benefits they have already been too long denied.

Building the cribwork of the cofferdam with which part of Niagara river was unwatered to permit of the construction of a wing dam on the Canadian side

Toxicity of Bog Water for Plants

THE injurious effects of bog water on plants, at least of certain species, has frequently been pointed out and discussed. Analyses of Ohio bog water, published by Foulk, and of water from a lake adjoining the bog, indicate that the bog water differs from the lake water in a higher content of organic ammonia and in greater loss on ignition. It has been shown by other investigators that the surface tension of bog water is not low enough to account for its toxicity. The fact that the osmotic pressure of bog water is very low suggests that the material in solution in it is probably in a colloidal state. This view seems to be confirmed by investigations described in a recent article by G. B. Rigg relating to examinations and analyses of water from sphagnum bogs of the Puget Sound region and Alaska. Apparently this colloidal matter is a large factor in the toxicity of the water.

Electric Steel

How the Temperature is Automatically Regulated in an Electric Steel Furnace

By William H. Easton

THERE is a new metal on the market—a newcomer into the all-important group of steels. Two or three years ago little was heard of it, but now it has passed out of the development stage and has a well established market, a strong demand, and a good round price. It is known as "electric" steel.

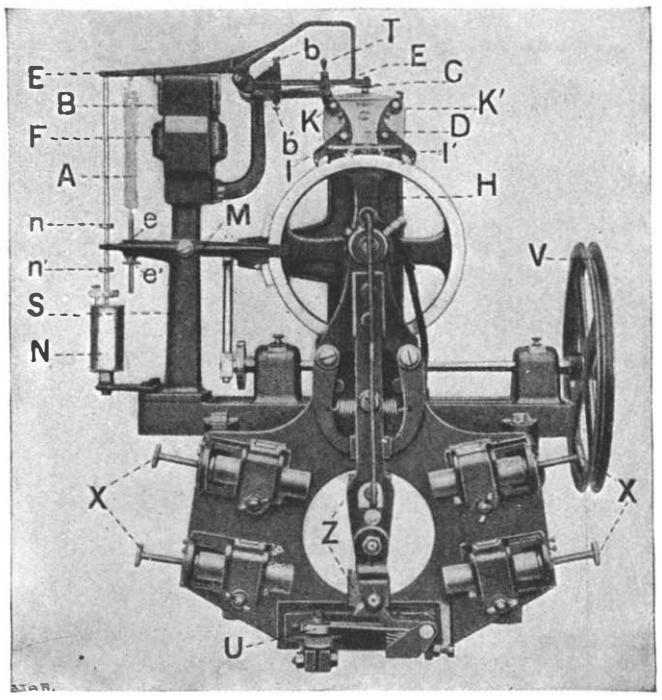
What is electric steel? It is simply the product of the electric furnace as distinguished from that produced by the Bessemer, openhearth, and crucible processes. Its superiority to the other steels lies solely in its method of production. The electric furnace can be operated at a much higher temperature than any other furnace, its temperature can be regulated with exactness, and its atmosphere is non-oxidizing. In consequence electric steel can be made of a high grade of purity, and being worked at a high temperature, is very fluid when poured and makes castings that are uniform and free from blowholes and flaws. It is therefore particularly desirable for small castings where great strength with light weight is desirable, as for automobiles and aeroplanes, for example. Furthermore, an electric furnace can be built in a few months, costs only a few thousand dollars, and will melt down and treat any steel scrap which is not too highly oxidized; whereas a steel crucible requires years for construction, costs a small fortune, and must be charged from an openhearth furnace. It is evident, therefore, that electric steel is certain to become an important factor in the steel industry.

In 1906 there were but five electric steel furnaces in this country; to-day there are 110, mostly built within the last three years, and during the current year 42 more were ordered. The first furnaces were used solely for the refining of high grade alloy and tool steel, but with the reduction of the cost of electric power, the perfecting of the furnace design, and the improvement in the method of operation, cheaper grades of steel can be refined, or even merely melted, electrically at a profit.

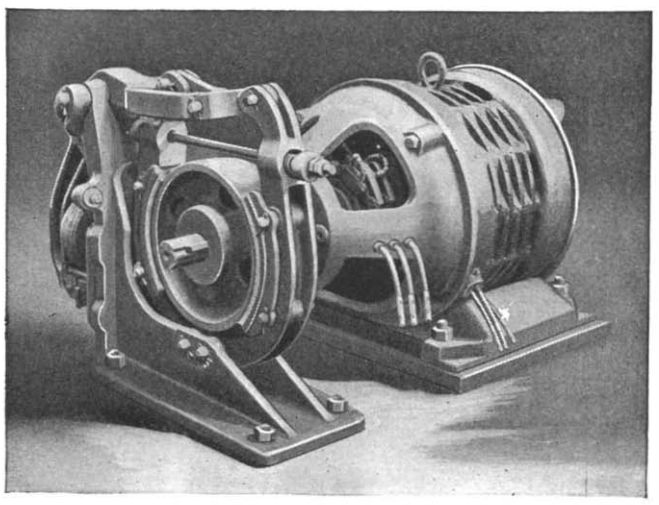
There are two principal types of furnace: the induction and the arc. In the induction furnace the charge forms the core of the secondary of a huge transformer and the heat is obtained from the large currents that are induced in it. Though ideal in many respects, this type has not found favor in America and practically all the furnaces in commercial operation are of the arc type. In the arc furnace, immense electrodes of amorphous carbon are suspended above the charge and the arc passes from one through the charge and back to another. In this way an extremely high temperature is obtained that melts and refines the charge very rapidly. These furnaces are built in sizes of from 1 to 20 tons in capacity, the 1-ton size requiring 375 kva and the 20-ton 3,750 kva. The 6-ton size, however, seems to have become the accepted standard.

The arc furnace is very simple in construction, consisting simply of an enclosed hearth, built of steel plate and fire brick, and the electrodes. Modern furnaces are usually of the tilting type; that is, the entire hearth is tilted by a motor for use in pouring the metal.

Three-phase 100-volt alternating current, of either 60 or 25 cycles, is used for most furnaces. In general, the power is received at a high voltage and is stepped down to the proper point by means of transformers, which must be specially designed to withstand the heavy overloads and other severe operating conditions obtaining.



Mechanism for regulating the electrodes of an electric furnace



Motor-operated winch for raising and lowering the electrodes

Quite the most interesting feature of the furnace is the apparatus for automatically regulating the strength of the current and, therefore, the temperature. This apparatus is a recent development and to it, more than any other one factor, is probably due the rapid extension of electric refining in the past few years. By its use labor is saved, current is economized, the time of treatment of each charge is reduced, the quality of the product improved, and the production is increased.

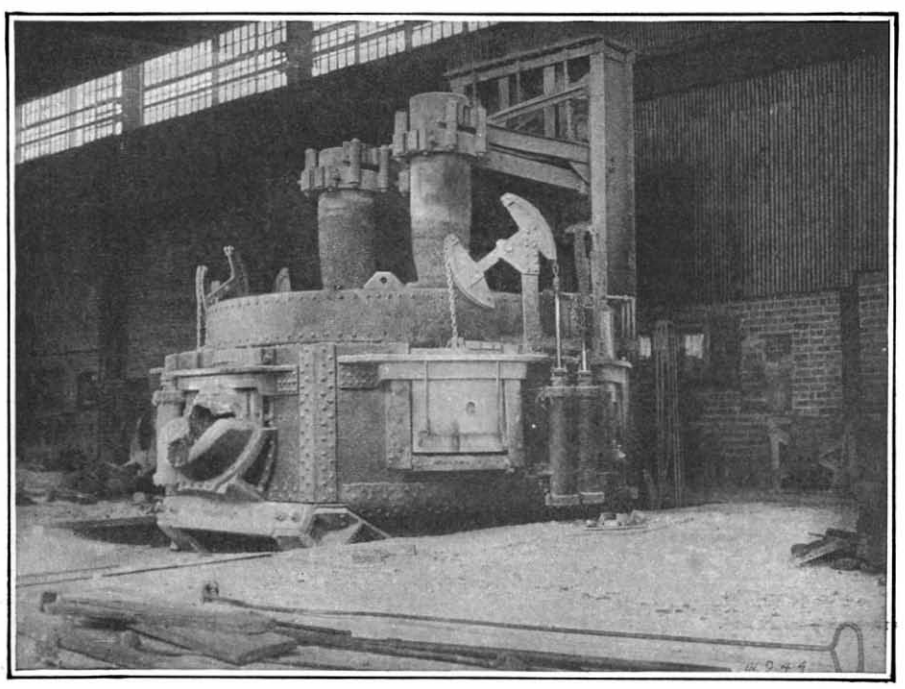
The regulator illustrated is used on a large percentage of electric furnaces installed in this country. The current is controlled by raising or lowering the electrodes by means of motor operated winches, thereby increasing or decreasing the resistance of the circuit. The winch motor is in turn controlled by the regulator, there being a separate motor and regulator for each electrode.

Referring to our detailed illustration of the regulator, the operation of the regulator is briefly as follows. At *F* is a solenoid energized by current from series transformers in the main circuit. Its pull will therefore vary with the current flowing through the furnace. When the furnace current is at its normal value, the rocking lever *E* is held in the equilibrium by the pull of the spring *A* and the magnetic pull of the fixed coil *F* acting against the movable coil *B*. When a current variation of sufficient duration occurs, the coil *B* will be either pulled toward or pushed away from *F* and then the lever *E* will either rise or fall. Without going into details, the result is that the arm *Z*, carrying heavy copper contacts, will be forced against one or the other sets of carbon contacts *X*, held there momentarily, and then swung back. This action starts the electrode winch motor and either raises or lowers the electrode slightly, depending on whether the current variation was an increase or decrease. If the movement of the electrode is not sufficient to restore the current to normal value, the arm *Z* will continue to make quick contacts with the proper set of electrodes *X* until the electrode has been moved sufficiently to restore normal value. Then the operation stops.

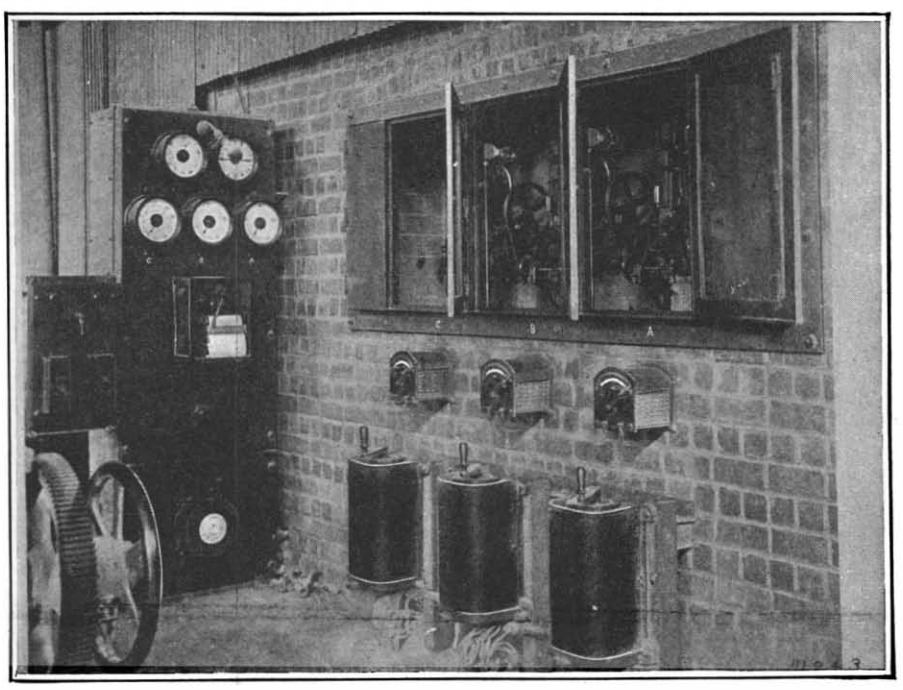
Sudden changes or changes of short duration will not cause the regulator to act. This is very important, as not only is there a great saving of wear and tear on the electrode hoisting mechanism, but the current is kept more uniform by avoiding the regulation of such changes. The regulator can handle any amount of power for regulating purposes without in any way impeding the free play of the controlling mechanism, which is only in contact with the power mechanism for exceedingly short periods of time and is otherwise perfectly free. The intermittent action of the contact making arms prevents the regulation from being carried too far.

Damage to Buildings by White Ants

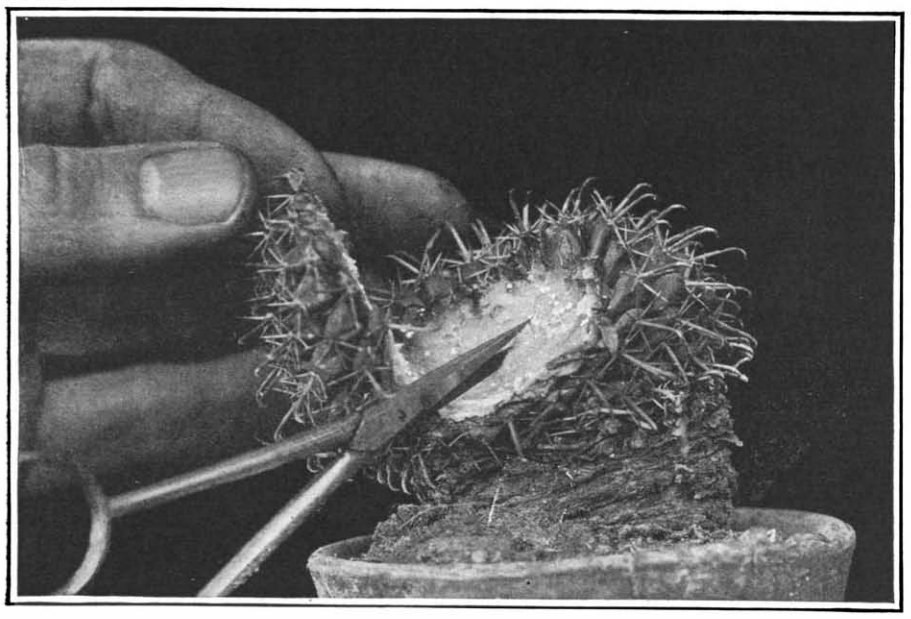
DURING the last fiscal year the Bureau of Entomology received 15 reports of more or less serious damage to buildings by termites, or white ants, the buildings including private residences, business houses, a church, a railway station, and the old building of the Bureau of Engraving and Printing, in Washington. Many documents in the last named building were damaged or destroyed. In many cases the reconstruction of foundations and floors is advised.



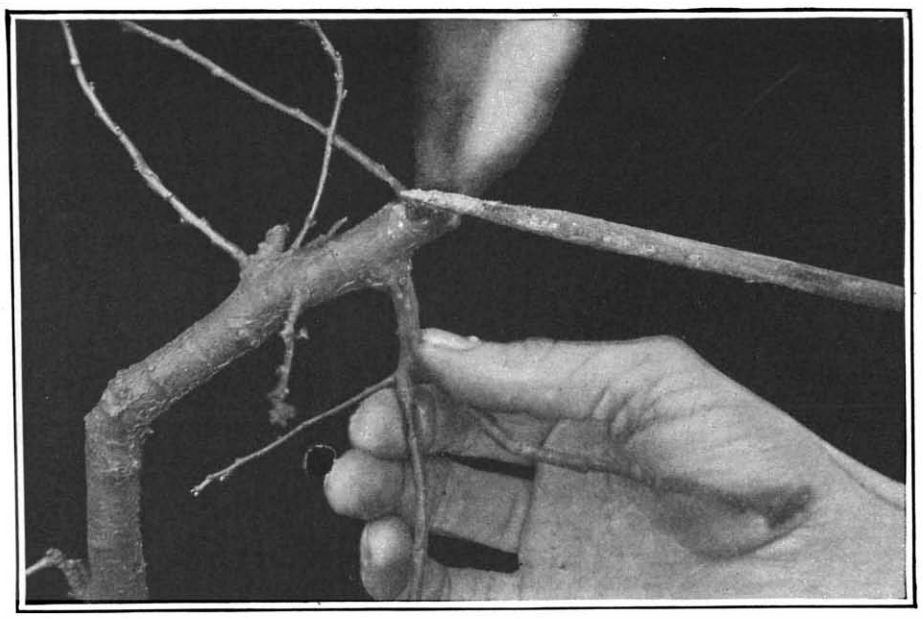
An arc-type electric furnace with a capacity of 60 tons of steel



A three-phase regulator installation—one regulator for each electrode



Surgery on the cactus. Rotten spots like these should be carefully cut away



Cauterizing an open wound on a plant with hot iron will stop the weakening flow of sap

Plant Surgery

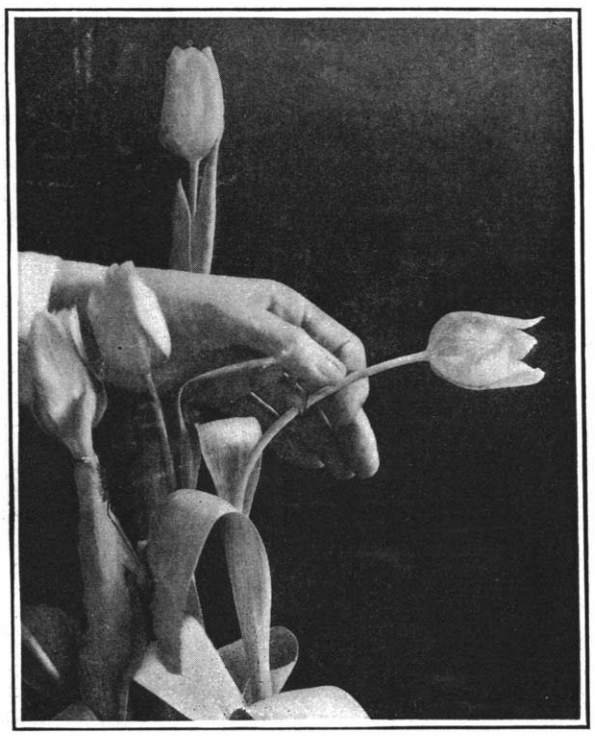
IT has remained for the modern gardener to discover that the plant is sometimes in need of surgical aid; that, more often than not, it languishes for want of a dose of medicine. Of course for some years we have had the tree surgeon, the man who scoops away the rot from bough and trunk, and fills up the hole with cement. But, nowadays, the matter is carried a good deal farther and the doctoring of plants generally seems in a fair way to become a highly important profession.

Even in the humdrum round of the market garden accidents will, at times, happen. A typical case would be on the following lines. A tree or a plant laden with fruit comes to grief through the sheer weight of the crop. A branch or even the main stem is half broken and, unless something is done to repair the partial fracture, there will be a considerable loss. But the gardener who has learned his lesson in first aid to plants is in no wise dismayed. First of all he places a couple of wooden splints on either side of the stem; then this is gently pulled into an upright position, after which the fracture is well bandaged up. In a wonderfully short time the severed portions join together, the wound heals, and the part which has been so badly damaged is stronger than it ever was before.

Although many people are hardly aware of the fact yet it is quite possible for a plant to bleed to death. This is especially so in the case of vines when the sap is rising at a great rate. After pruning it sometimes happens that the sap will pour from a severed branch. Literally the plant is bleeding to death and all the energies of the growers are directed towards preventing a great loss. To this end drastic measures must be adopted. As a rule the most certain styptic is a red hot iron and one witnesses the operation with rejoicing that plants are not conscious of pain.

Cactus plants are especially liable to a most devastating disease. Not much is known about the cause of the trouble, but it takes the form of a complete destruction of all the healthy tissue. In a few weeks a sound plant may be converted into a mass of unwholesome rottenness and it will be realized that the specialist keeps a sharp lookout for the first sign of trouble. The only course to follow involves a severe operation which consists in the excision of all the diseased portion. The surgeon is not content until he has cut right down to the healthy succulent flesh. As one would expect with desert plants the cacti have a wonderful constitution and soon recover from the effects of the operation.

The idea of applying massage to plants is probably Japanese in origin. Gardeners all over the world are now beginning to realize the value of the treatment. It may be successfully carried out in the case of any growing or non-woody part of the plant. Much attention is now given to the production of well-balanced plants but, quite often, a part of the specimen, it may be only the stalk of a single flower, persists in growing out of character. Such a case is an ideal one for massage. Gently but firmly the wayward part is induced to assume a better position and, although an obstinate case may take some time, the plant finally yields to the persuasive touch and regains its correct posture.



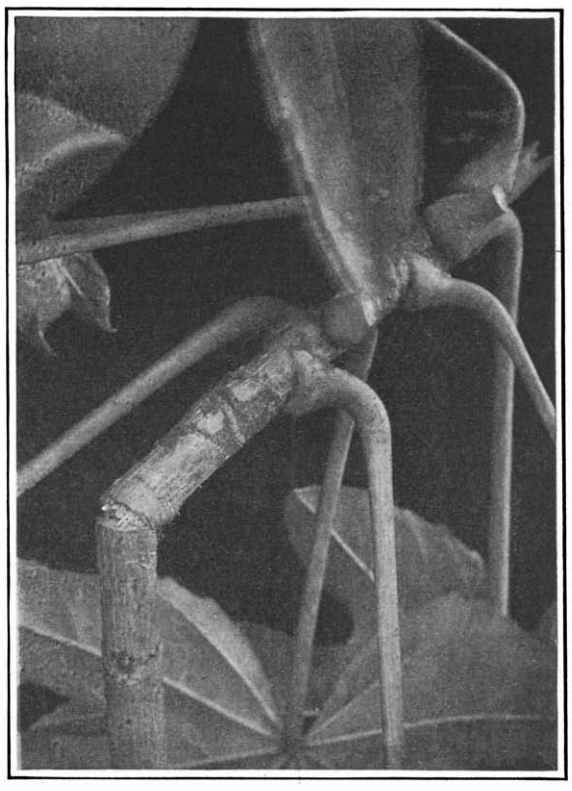
Correcting an ill-proportioned plant by means of massage

The purely medical treatment of plants is one which calls for a great deal of attention nowadays. It would seem that some plants suffer from a kind of anemia, the chief symptom being a poor development and a bad coloring of the flowers and foliage. For such a condition, plants are treated quite as are human beings; iron is the recognized remedy. The outcome of a course of iron in some form or another is very bright green foliage and better colored flowers. In some cases an application of iron to the soil in which the plants are growing will have a surprising result. Thus the mineral will induce pink-flowered hydrangeas to produce blossoms of a bright blue color and will affect similarly individuals of other species.

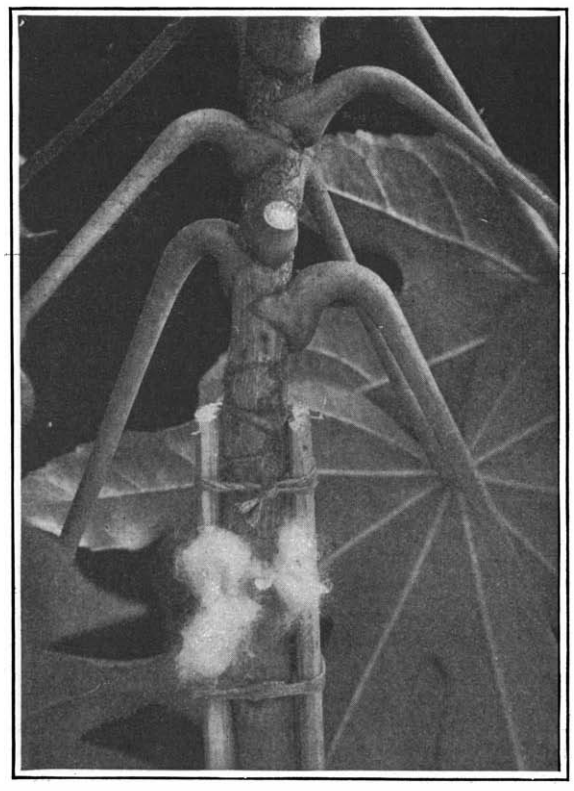
Even more astonishing were the results of some experiments to show the effects of alcohol on plants. It appears that many white flowers have the needful elements for the building up of color. They simply remain colorless because these elements are kept apart. Cases in point are the white Sweet William and the white primula. Quite a small dose of alcohol is sufficient to bring the elements together, and the flowers assume their proper shade. Some white species are so far gone, however, that they have entirely lost the elements known as color producers. In these cases no amount of dosing will have the least effect; the whiteness has become an immutable characteristic.

Plants are singularly like human beings in that they benefit by a change. Potatoes are quite remarkable in this respect. Thus to continue to grow the same variety year after year in the same locality is very unwise. Every season it is best to grow a variety that has come from a distant district. Then again the reader may have noticed that the wild and garden flowers by the seaside appeared to be larger and brighter in color than those which he was accustomed to see in inland places. Although the reason has never yet been explained there is no doubt that the idea is correct, and that blossoms are really finer within a few miles of the coast line than they are ever to be found in any other locality.

It is to be feared that our modern races of plants are suffering from over-civilization. In the effort to secure unusual varieties and bizarre effects the specialist raises his plants in such artificial and sheltered surroundings that, too often, they are not able to withstand the rough and tumble of life under natural conditions. Indeed, so unfit in the struggle for existence has the plant become that at times it cannot even carry out its ordinary functions without extraneous aid. As an instance consider the position of the modern melon which has been induced to bear fruits so large that the plant is quite unable to support them, so that it is necessary to put the fruits in nets, or make some other arrangement to aid the enfeebled plant. It seems likely that, as time goes on, the new races of plants will require more and more aid to help them through life.



Broken by the wind and apparently doomed

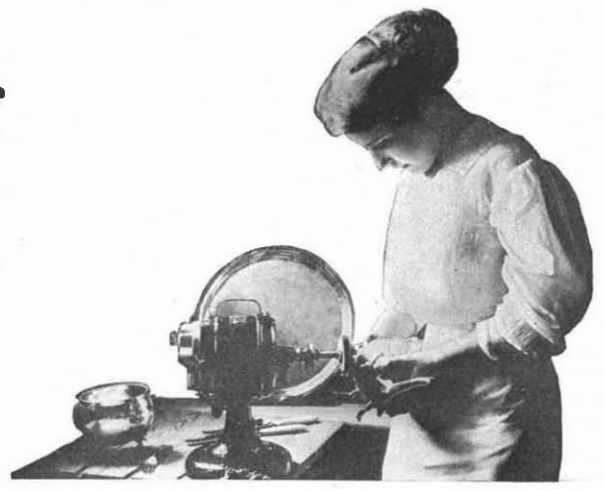


This plant can be saved by skillful use of splints

Electrical Invasion of the Home

A Myriad of Conveniences Afforded by this Silent, Noiseless, Wonderful Power

By C. H. Claudy



NEWSPAPERS refer to this as the "electrical age." So indeed, it is, for the manufacturer, the scientist, the transportation company. For householder and home maker, the "electrical age" is just beginning.

The same timidity which made the gas stove follow gas lighting so slowly is but slowly being overcome in the case of electricity. It is not so long ago that we first put electric lights in houses with fear and trembling—only recently houses are wired for lights and gas-piped only to the kitchen. As yet, but one house in a thousand is wired in duplicate—one circuit for light, and one for heat and power. Experiments with electricity in the home are as yet tentative, and made almost altogether on the lighting circuit.

Every manufacturer of electrical apparatus knows this condition is not permanent, but electricity must make its way against prejudice, fear and the tightly-held pocket book, even as gas had to do.

Why two circuits? The electric companies are always explaining, yet few know the answer. The gas company makes gas by heating coal. The product, after various additions and refinements, is stored in a tank, where it remains until it is used. The electric manufacturing company cannot so treat its product. Electricity cannot be stored economically; the successful storage battery for anything but small consumption of current, being as yet a dream. Electricity must be used when made. Consequently, the generating station runs to full capacity at night, and is largely an idle investment during the day. Electricity, then, is more expensive at night than in the day. Anything which can use current in the day time, can be run more economically than at night.

Cooking, heating, and power uses of electricity are largely day-light operations. Therefore, the power company can afford to sell current for these purposes for less than it can dispose of current for lighting. Hence, two circuits in a house, two separate meters, make for an economy of electrical cost. In a city where the "standard price" of ten cents a kilowatt obtains for lighting, a heating and power circuit can be run, usually for five cents a kilowatt. In some places it is as low as three cents, and, where water power is converted into current, often less. In some places special summer prices can be obtained if electrical cooking apparatus is installed. As less electricity is used in homes for lighting in summer than in winter, the power company is anxious to increase consumption during the heated months.

But little electrical conveniences for home use are as yet almost invariably supplied with a plug and cord for connecting to the lighting circuit. It is to throw some light (sic!) upon the character, safety, ease and convenience of use, and slight cost of operation of these conveniences, even on the lighting circuit, that this story is written.

The most familiar household electrical convenience is the fan. We are used to fans. We knew of electric motors in street cars before we ever had an electric light in our houses. We found out that electric motors were perfectly safe. Business houses installed fans in stores—private offices took them up—now thousands of homes have them to make summer endurable.

The cost of operation of a fan is much smaller than the unknowing imagine. An 8-inch fan, of four blades, weighing eight pounds, and costing less than ten dollars, can be run for five hours at a cost of one cent at the high speed of 1,600 revolutions per minute. Such a fan in the dining room used a total of two and one half hours a day costs fifteen cents per month! Larger fans cost proportionately more to operate, but even a 16-inch fan can be run for from two to four cents a day of five hours! Thus it is perfectly possible to have half a dozen fans in the home, and increase the electrical bill by only a dollar or a dollar and a half a month; surely a pitifully small price to pay for the comfort of a cool breeze in humid weather!

Electric current can be turned into power and into light, more economically than it can into heat. The end and aim of an electric light is illumination—as much as possible spread over as large an area as possible. The nature of the motor makes it possible to concentrate the current into the power at the place it is wanted. When heat is desired, it is usually wanted at one place and no other—the end aml aim of the manufacturer is to devise apparatus which will confine the heat to the one place so that as little as possible may be lost.

As far as cooking is concerned, heat is wanted for but a short time. An electric toaster on the breakfast table, may use 500 watts of current—which means five cents an hour. If one ran the toaster all day long, it would cost 50 cents for ten hours, or fifteen dollars a month on the electrical bill! Most householders would regard that as a prohibitive price. But one only wants a toaster to run for a few minutes. If the toaster is operated on a total of 15 minutes at the breakfast table, it will make all the toast a family of six can possibly eat. The cost will be something less than 40 cents for the month. Its great advantage over any other method of making toast is the fact that you get the toast red hot, right off the stove, and that it is absolutely even in its browning. The little wires which glow dull red do so with equal heat everywhere—there is never a burned corner, or a white, uncooked spot on electric toast. Such pieces of apparatus, small enough to stand upon an ordinary coffee rest, come for such small prices as $2.50 up, and need no further preparation for use than unscrewing a light bulb and screwing in the plug with which the toaster comes connected, in the thus emptied socket.

Similar apparatus can be had for almost any operation of cooking which can be managed with less than a whole kitchen stove. Chafing dishes, tea-urns, coffee-makers, tea-kettles, tureens, both for keeping soups and stews hot, or for making them *in situ* if desired, egg boilers, batter-cake stoves, water heaters—are all manufactured for dining table use. All connect with flexible cord to the nearest lamp socket, or, in case such an outlet is available, to an opening in the floor beneath the table.

Individual pieces require varying amounts of current, but most take about 500 watts for each "burner." Few have more than one "burner" although there is an "electric table range" which comes with two "burners" or heating surfaces.

Apparatus of this kind is equipped with a switch for regulating the heat. Unlike the gas stove, "heats" cannot be obtained in all possible degrees from minimum to maximum. The electrical heater which gives more than one degree of heat, has that degree controlled by the amount of current consumed. It would be perfectly possible to make such apparatus with a dozen variations of possible heat, but in practice, three "heats" are found sufficient. They are called "low," "medium" and "high," and generally the lowest heat requires one fourth the current of the highest. If the lowest "heat" consumes 250 watts, the "medium" heat will consume 500 and the "high" heat 1,000 watts.

As a general rule, even on a double "burner" range, from two to four cents will be the price of heat for the meal. If an elaborate meal is attempted, the cost will run higher, but at the most, it is scarcely more than the cost of alcohol in a chafing dish, and is without alcohol's muss, bother or danger.

The cost of dining room cooking apparatus varies greatly with the material used, the finish, and depends to some extent on the quality of the heating units. Nothing but the highest quality of heating unit pays, aml practically all the well-known makes of electrical specialties are now incorporating the best of electric work in their plated or solid copper apparatus. In few cases is the cost of such apparatus more than the cost of similar apparatus of like quality with an alcohol heater. Of course, some cannot be duplicated with an alcohol heater—the toaster, table range, etc. But it can be safely said that any one who wants a piece of table cooking apparatus will not have to pay more than a couple of dollars more for it if electrically heated than for the same thing in the same size and finish, equipped for the familiar blue flame heater of alcohol.

Because the heat in such apparatus is intensely localized—the frame of a table range is cold while the "burner" may be sizzling hot—the radiated heat is almost nothing. It does not raise the temperature of a room a degree to cook with a one "burner" electric stove for half an hour. For this reason, the usual objections to chafing dish suppers in hot weather disappear. The relative safety of electrical table cooking apparatus is measured in terms of open flame vs. no flame at all. Leave a chafing dish in operation and go upstairs after something—there is always danger of a curtain blowing into the open flame, or something or some one upsetting the alcohol and setting fire to the house. An electrical heater, having no open flame, is not affected by drafts, and as there is nothing inflammable about the heater itself it can be upset without the slightest danger.

Electrical conveniences are by no means confined to fans and cooking utensils. A host of little things electrical, from milady's curling iron to a washing machine in the laundry, do not touch the dining room at any part. Perhaps none are more important than those which add to the comfort of the sick room, and of these, the electrical heating pad and the electrical heating blanket take first rank.

The electrical heating pad is the apotheosis of the hot water bottle. If you can imagine a hot water bottle which stays hot, is without weight, isn't "floppy" and "roly-poly," stays where it is put, has no appreciable thickness, can't leak or burn, aml which can be regulated as to the amount of heat it gives, you will have a very good idea of the electrical heating pad. Most of them are made to give three different "heats" of which the maximum is about 180 degrees—a greater heat than can be borne by the skin, and useful only when a poultice or wet compress must be between the heating pad and flesh. Such pads are flexible and come in many sizes from little ones a foot square, to blankets which cover the entire bed, especially designed for outdoor or sleeping porch use. They reduce the quantity aml hence the weight of bed clothes required to keep a sleeper warm in the coldest weather.

The current consumption in the smaller sizes and for the low heats, is so minute as hardly to be measured. From ten to fifteen watts will keep a small pad hot, so that the total current consumption for a ten-hour sleep would be less than two cents. For all muscular pains and aches and for any purpose where a hot-water bottle can be used, the electrical pad is far more practical, convenient and safe. Such pads run from a few dollars up in price according to size, and most are equipped with removable rubber covers so that wet applications can be made. The pads are light and flexible so that they can be wound around the head or laid flat upon the stomach, two applications for which the hot water bag is notoriously uncomfortable.

The electric vibrator is an electrical means of producing mechanical massage. It is not, as is often supposed, a method of applying electricity to the body. It consists of a very small electric motor, so connected to an extension arm that the arm is made to vibrate or move back and forth at a tremendous speed. Putting "applicators" or rubber ends of various sizes and shapes on this arm, enables that rapid vibration to be passed onto aching muscles or undeveloped parts of the body. The result is the same as with hand rubbing, only more so. Where the hand rubs a hundred times a minute—and it is a good massage artist who can make so many strokes—the vibrator rubs thousands of times.

Another sick room accessory is the ozonizer—a device which changes some of the oxygen of the air into ozone, that peculiar form of oxygen which is so life and health-giving. It is particularly useful to remove odors, and keep the air fresh even in a tight room. Both the ozonizer and the vibrator are inexpensive pieces of

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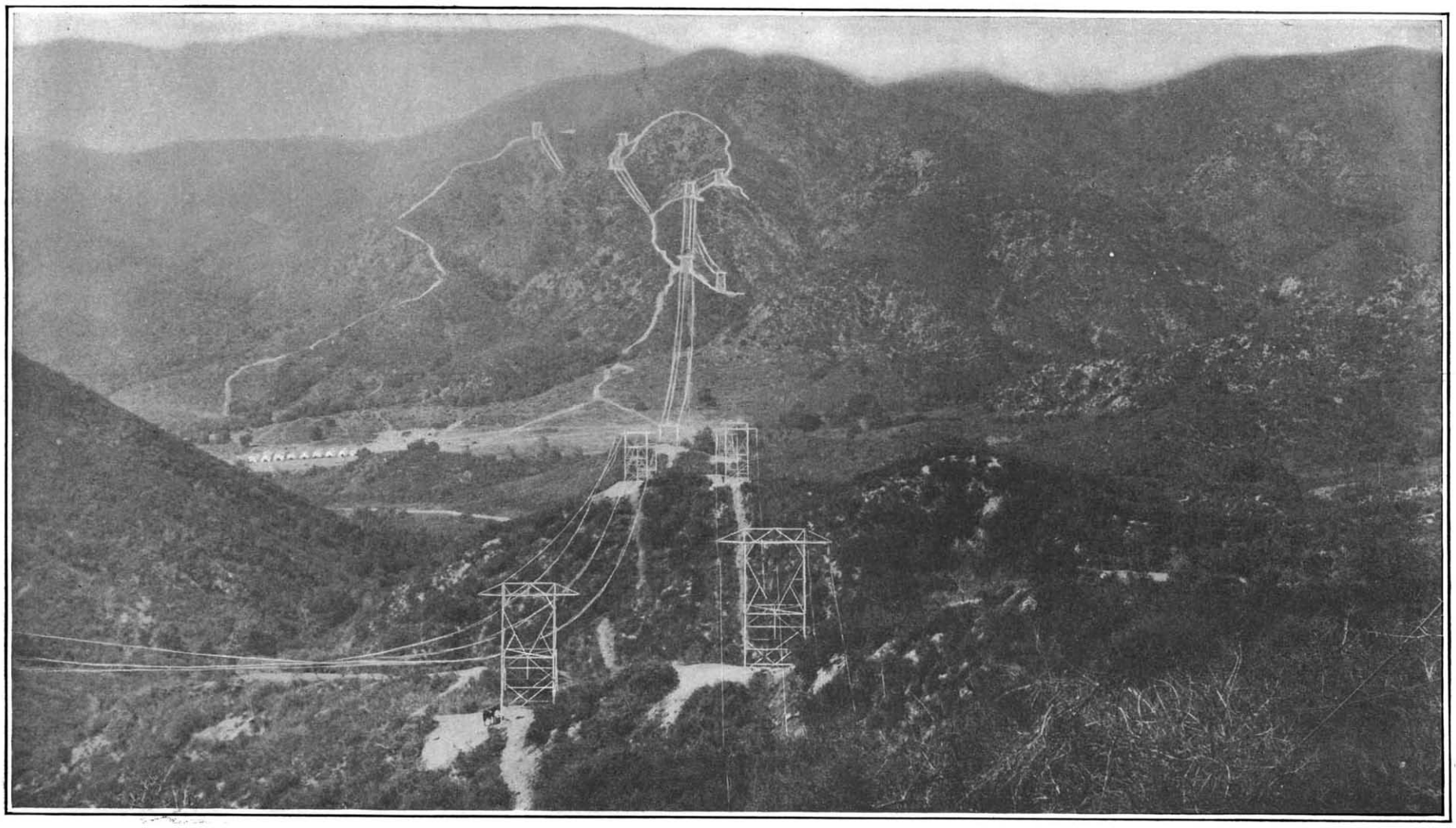


The 150,000-volt power-transmission line that runs from Big Creek to Los Angeles, California, a distance of 240 miles

Have We Reached Limit of Power Transmission?

An Interview With Dr. Charles Proteus Steinmetz

FED by melting snows high up in the Sierras, a comparatively small stream comes tumbling down the mountains. Small as it is, this little stream is capable of doing an enormous amount of work; for in a distance of six miles it drops four thousand feet. When it has been fully developed its output of electricity will compare favorably, if it does not exceed that of the great Mississippi River, at Keokuk. Already it has reached a number of world's records, but those which concern us most in the present article are that the power it develops is transmitted over the greatest distance and at the highest voltage, of any transmission line in the world. The current is raised to a pressure of 150,000 volts and then started upon a journey of two hundred and forty miles over mountains and valleys, through wooded lands, and desert wastes to Los Angeles, where it is stepped down again to a practical voltage for the operation of street cars, lighting of buildings, and the thousand and one other modern services of electricity.

Such a high voltage was undreamed of a few years ago. The problems of high tension transmission were so complex that even sixty thousand volts was spoken of with awe. That mysterious phenomenon known as "static" and the dangerous breakdowns or short circuits that were prone to wreck the line or the apparatus which it fed, were apparently insuperable obstacles.

The one who solved the problems and to whom belongs the credit for the present remarkable development of long-distance transmission lines is a man who has loomed up above the horizon of public attention in the last four or five years. We can look in vain in our encyclopedias for mention of Dr. Charles Proteus Steinmetz, and yet he has been known to the electrical fraternity ever since he delivered a highly mathematical paper on magnetic hysteresis before the American Institute of Electrical Engineers in 1892.

Dr. Steinmetz' inventions have not been of the type that would attract the attention of the man on the street, and consequently his work has escaped popular attention; but in the construction of enormous power plants and transmission lines the public is given ocular evidence of the value of Dr. Steinmetz's work.

A member of the staff of the SCIENTIFIC AMERICAN recently paid a visit to Dr. Steinmetz in his home at Schenectady, New York, to learn something about the future of power transmission. According to a recent estimate of the Geological Survey, we have in this country 61,678,000 potential water horsepower, which if developed in steam plants would require the annual consumption of 340,000,000 tons of coal. Only 10 per cent of our hydraulic resources are now being used. There is a wonderful opportunity for further development, provided the power can be transmitted to points where it is needed. What we wished to know was whether there is any probability that power from remote mountain streams will be transmitted over much greater distances than at present or whether we have about reached the limit of progress in this direction.

Dr. Steinmetz has been called a "pencil inventor." Instead of making his discoveries by experiments, he proceeds first to reason matters out with the aid of his pencil, and the short-hand logic of mathematics. When he arrives at a conclusion, the experimental confirmation usually follows as a matter of course.

As an example of his method of procedure, we are told that in the earlier days of the steam turbine a great deal of trouble was experienced in building units that would develop more than 5,000 horsepower. Apparently a limit had been reached with the particular type of turbine in question, despite every effort of a number of engineers associated with Dr. Steinmetz. Finally, some one mentioned the matter to Dr. Steinmetz. He asked for the blue prints of the turbine. He never looked at the turbine, he never even went near the factory, but merely worked the thing out on paper. In a few days he handed back the blue prints with new curves plotted for the turbine blades. The problem was solved. The new design was a success. The turbines are now made in units of 50,000 horsepower.

When the question of the limits of power transmission was put to Dr. Steinmetz, he tossed the matter off as of minor importance.

"We are not limited by distance," he said. "In any well settled country there is no reason for transmitting current over enormous distances. What is Niagara Falls distribution? Practically all of the current is consumed within a very short distance of the Falls. Some, it is true, is transmitted to a distance of about 150 miles, but there is such a ready market for current close at hand that it is hardly worth while sending it far off. Buffalo is but twenty miles from Niagara Falls and yet it is putting up a steam power plant now, because it cannot get enough electricity. In any well settled country if the current is not consumed in the immediate vicinity of the power plant it is because the public has been educated to the advantages of using electric power, heat and light. As for unsettled regions, of course, power will have to be transmitted over considerable distances until the density of population becomes greater, when long distance transmission lines may be dispensed with. Distance is no longer a bar to the hydro-electric engineer. Why, the plans were all worked out for a 200,000 volt transmission line seven hundred miles long, in South Africa. This was to take power from the great Victoria Falls and transmit it to the Rand Mines."

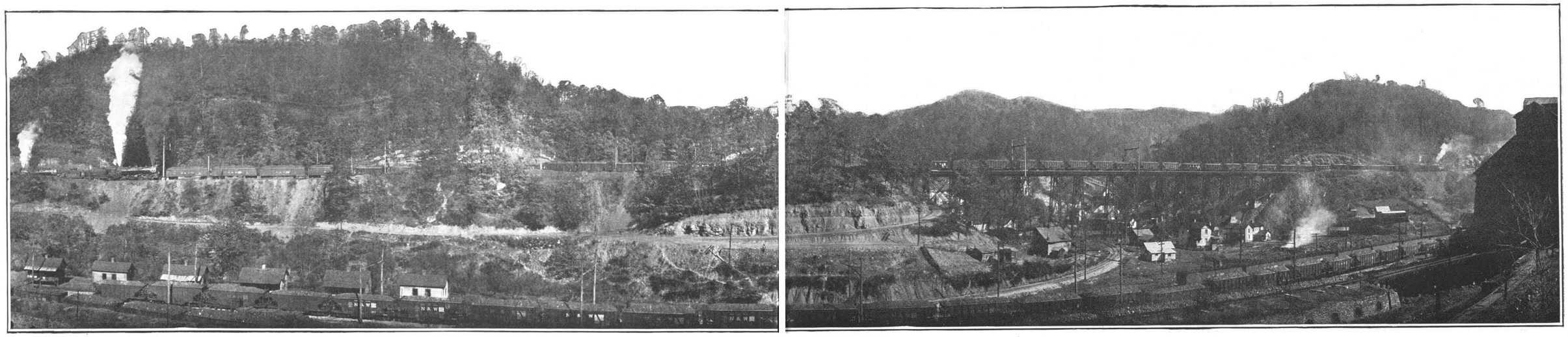
"But, what about insulation?" he was asked.

"The problems of insulation have all been solved," was the answer. "The next development of power transmission will be all in the matter of organization. It is not likely that we will ever be called upon to build a thousand-mile transmission line. By the proper organization and cooperation of the various electrical companies, the transmission of power can be very much simplified and this will result in a wider distribution. Also, the public will be educated to the use of electricity so that there will be a ready market for electric current wherever it is produced. This will not necessarily result in centralizing the industries about the power plants. Electric power will never take the place of steam power because there is not enough of it. In the future the man who lives more than a hundred miles from a hydro-electric plant will have to get along with electric power generated at a steam plant.

"But there is another form of power transmission that holds out great promise, and that is the substitution of electricity for transmission gearing in automobiles. The gasoline-electric automobile has not yet been properly developed, but it is the coming thing. Electricity provides the most flexible form of gear transmission. Another marked development along this line is the turbo-electric propulsion of ships.

"One of the disadvantages of electricity is the fact that it cannot be stored properly. This results in the placing of enormous demands upon the power plants at certain periods of the day and certain seasons of the year, whereas the load should be constant throughout the twenty-four hours in order that the maximum efficiency may be obtained.

"Laboring classes have been demanding an eight hour day and they are getting it. This is but a step toward the six-hour day. As the time of work decreases the cost of output increases because the machinery of a factory has longer periods of idleness in which it fails to return any income on capital invested in it. As the result of decreasing hours of labor factories will have to operate night and day, because it will be uneconomical to operate for such short periods of time. This will work to the advantage of the electric plant, for it will mean a better distribution of the load, not only in the manufacturing plant, but also in the production of electricity for domestic consumption. It will turn night into day; for workmen on the night shifts will have to re-arrange their hours, and hence we will have a more uniform output of current for cooking purposes in homes. This will enable electrical plants to work at maximum capacity throughout the entire cycle of the day."



Heavy coal train on the Norfolk and Western Railway before electrification laboriously limbing a grade, with a powerful Mallet type locomotive pulling and two Mallets pushing

Electrification of Steam Railroads

Directions in which this Form of Traction is Likely to Expand

By George Gibbs

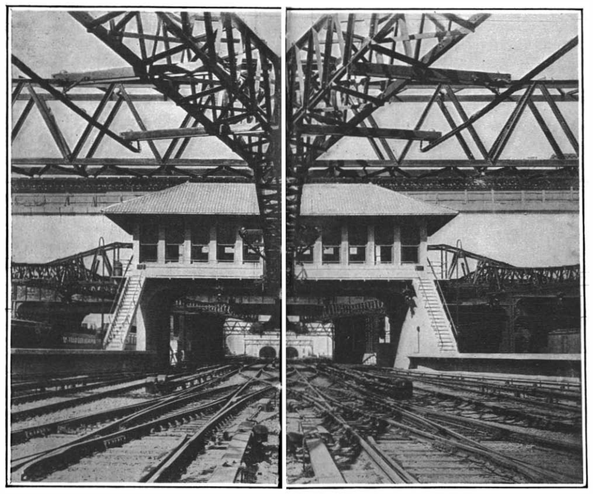
TWENTY-ONE years ago, the Baltimore & Ohio Railroad Company tried a bold experiment to meet a difficult problem in the operation of its new cut-off line through the heart of Baltimore. The new passenger station on this line was approached through a heavy-grade tunnel a mile and a half long and, as traffic was both freight and passenger, it was evident that the smoke and steam from locomotives would produce an unpleasant and, perhaps under some conditions, a dangerous situation. As it was desired to make this new line attractive to the public, the company resolved to try electric operation, a decision which was a revolutionary one in those days both for the railroad and the manufacturers of electric apparatus, because it involved the designing of traction motors of unprecedented power and new and almost untried methods of conveying enormous electric currents to the locomotives by some form of continuous contact system along the tracks. The system, however, was successfully inaugurated and, barring some changes in the contact which were subsequently found necessary, it is still in operation with substantially the original equipment and may be said to mark the beginning of the electrification of steam railroads not only in this country but abroad.

Progress elsewhere with this new form of traction for heavy railroad work was, however, not rapid until about 12 years ago, at which time the great modern development of underground stations in large cities was taken up and introduced a new set of difficult operating conditions which precluded the use of combustion methods in the train motive power. These important terminals, of which the Pennsylvania and the New York Central in New York City are examples, provide for not only long distance main line but short distance suburban trains, and the traffic is dense. It was found that for their practical operation the electrified divisions must not only comprise the relatively short portions of the lines within the city, but must be extended over the suburban zone served by the terminal; for example, the tunnel entrances to the underground terminals of the Long Island Railroad required the electrification of a network of 88 route miles or about 210 track miles outside of the city, in order to give frequent and quick service without transfer for the crowds of daily commuters.

The technical success of electric apparatus for moving heavy trains also indicated other places on railways where it might be useful, so that at the present time it may be said that electrification furnishes steam railroads a suitable means for:

1. The elimination of smoke in tunnels.
2. The conduction of a rapid and dense suburban service.
3. Increasing the capacity of overworked lines and terminals, and of haulage on heavy mountain grades.

A statement of these useful accomplishments of the new form of motive power might lead one to expect that the steam locomotive is destined ere long to go the way of the horsecar into oblivion, but before jumping at such a conclusion the financial aspect of the problem must be considered. The most comprehensive examination into this phase of the question is contained in a report which has just been published by the Chicago Association of Commerce. This impartial investigation, extended over a period of four years and involved the expenditure of over one half a million dollars in collecting data.



Overhead construction at switches in the New York terminal of the Pennsylvania Railroad

The special problem examined into by the Chicago Association was that of smoke abatement within the city. The public and the officials were convinced that the railroads were responsible for the smoky condition of the city's atmosphere. It is conceded that Chicago is a smoky city and that material damage is caused to property and inconvenience to the public by the presence of this smoke; consequently, the demand went forth that the steam locomotive be eliminated. In order to end charges and countercharges in the daily press and elsewhere, the Association of Commerce by agreement with the city and the railroads undertook through a joint committee of city officials, business and railroad men, and with a very complete technical staff, to make a thorough investigation of the whole question of responsibility for smoke and the means for its abatement.

It was found that to eliminate the steam locomotive as a smoke producer within the City of Chicago would involve the electrification of 23 trunk lines which enter the city and which handle, aside from the large passenger traffic, an enormous amount of freight, requiring extensive freight yards and inter-connecting transfer lines. The mileage required to be electrified to make the scheme practicable as an operating proposition was 3,439 in 1912, a track mileage twice as great as that of all the then existing electrically operated steam railroads in the country and 15 per cent greater than of the entire world. As regards traffic, especially that of freight, the extent of car mileage to be dealt with in Chicago is about ten times that of all American electrified steam roads and, as regards freight switching, 65 times as great as in all existing electrically operated switching service elsewhere.

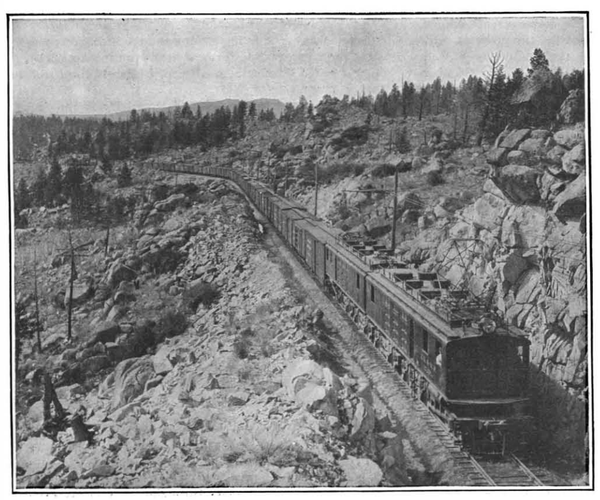
One of the most important results of the study was the discovery that while the railroads burn in the city 2,815,400 tons of coal per year, they are by no means the chief contributors to the smoke nuisance. Only 13 per cent of the total amount of coal consumed in the city and its immediate surroundings was burned in locomotives, and of the smoke produced only 22 per cent of visible smoke could be laid against the railroads, and only 7.47 per cent of the solids in smoke was attributable to railroad transportation. By far the chief offender in visible smoke is the high pressure steam stationary power and heating plant, which contributed 44.99 per cent, while the furnaces for metallurgical and other processes contributed 28.63 per cent and these furnaces also were responsible for 64.26 per cent of the solid constituents of smoke.

However, the investigation did not end here, but went deeply into the relative advantages of electricity and steam. A study was made not only of existing electrified lines in this country, but of those in Europe. Estimates were made of the cost of installing electric service in place of steam and a careful accounting was made of the operating costs under the electrical system as against steam.

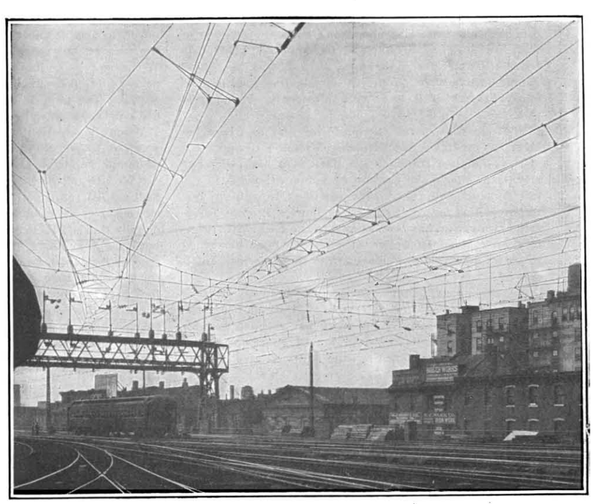
It was found that electric traction would produce operating savings. The annual saving in operating expenses worked out to be over $2,000,000, for the entire scheme, but, unfortunately, to save this two million dollars, nine million dollars would have to be raised each year to cover interest on the capital invested, and eight million dollars more to cover depreciation, taxes, and replacement of dissipated assets.

The investigation of the Committee into the various electrifications, here and abroad, will be found most interesting. In every case some special condition made it necessary or advisable to substitute electricity for steam. In no case where the service was satisfactory

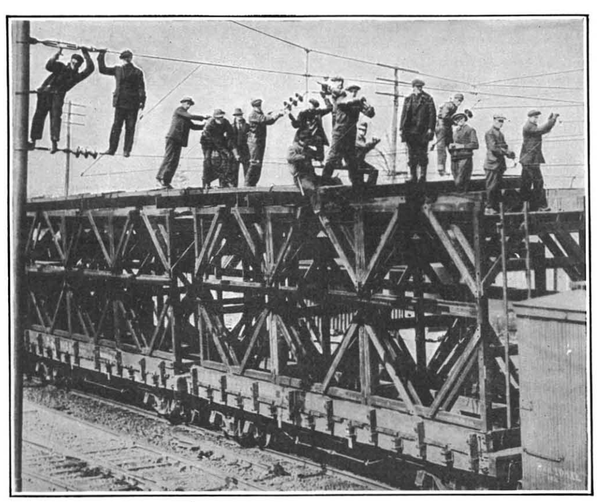
(*Continued on page 516*)



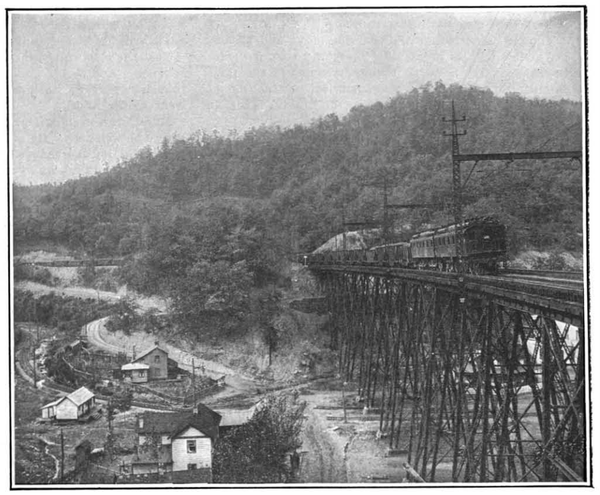
Running down grade on the electrified section of the Chicago, Milwaukee and St. Paul R. R.



A net work of wiring at the throat of the Broad Street Terminal, Philadelphia



Stringing the overhead wires of Philadelphia — Paoli electrification



An electric locomotive in service on the Norfolk and Western Railroad

The Heavens in December, 1916

The Moons of Jupiter and Saturn

By Prof. Henry Norris Russell, Ph.D.

THE winter constellations—on the whole the finest groups in the heavens—are now well displayed in the evening sky, and their brilliancy is enhanced by the presence of two great planets, Jupiter in Pisces and Saturn in Gemini.

The amateur, though he may possess only a small telescope, or none at all, will find much to interest him here. Even a field-glass will show the four moons of Jupiter, and. with a fairly powerful binocular, their progress in their orbits, from side to side of the planet, may easily be followed.

The two inner satellites are too close to the planet to be easily seen with a field glass unless they happen to be near their greatest apparent distance from the planet, and go round him so rapidly—in 1¾ and 3½ days, respectively—that it is not easy to follow them from night to night. But the third satellite, which takes a week to complete a circuit, recedes to a distance of nearly six minutes of arc, or one fifth the apparent diameter of the moon, and the fourth to a distance of almost 10 minutes, so that the reason why it cannot be seen by the naked eye is its faintness, compared with Jupiter, and not its closeness.

The third satellite will be found on the east of Jupiter on December 2nd, 9th, 16th, etc., and on the west at dates half way between, while the fourth is at its greater distance east on the 7th and 24th, and its greatest western elongation on the 16th—its period being a little less than 17 days.

The satellites of Saturn are fainter but the brightest of them, Titan, is easily visible with a small telescope of 3 inches aperture, appearing like a small star, circulating about the planet in 16 days, at a maximum distance of a little over 3 feet of arc, or about 4½ times the greatest extent of the rings. He is east of the planet on December 6th, north on the 10th, west on the 14th, south on the 18th, and so on.

The three satellites whose orbits lie inside that of Titan—Rhea, Dione and Tethys—may be seen with an aperture of 5 or 6 inches, as may the outer satellite Iapetus, when it is on the western side of the planet (which is the case on December 1st, the period being about 80 days). This satellite has the very remarkable peculiarity that it is almost five times as bright when west of the planet as when east of it—its brightness varying between these extremes in a regular fashion according to its position in its orbit. Though at first sight amazing, this is easy enough to explain, on the assumption that the satellite keeps always the same face toward the planet, turning upon its axis once in a revolution and that the side which we see at the western elongation is, on the average, very much lighter in color than the opposite side—which must, indeed, be a very dark gray in hue.

The two innermost satellites, Enceladus and Mimas, are visible only in larger telescopes, and very powerful instruments are required for observations of the faint satellite Hyperion, whose orbit lies just outside that of Titan, while the minute outer satellite Phoebe, is visible only with a few of the very greatest telescopes.

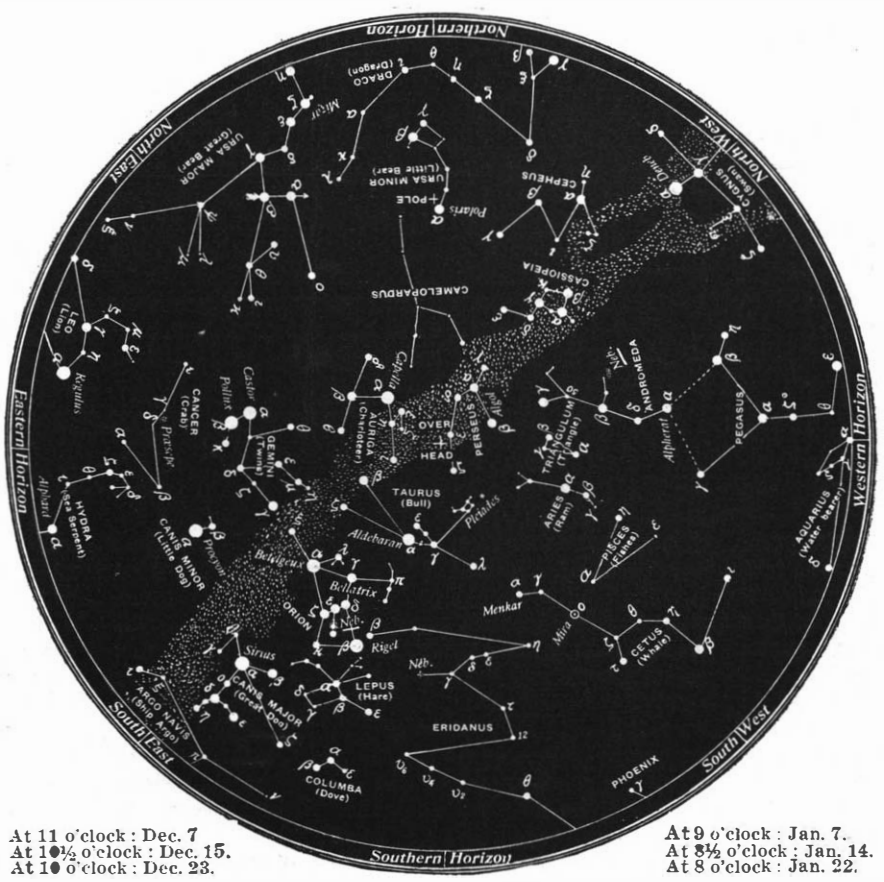
Only Titan, the largest of the nine, shows a measurable disk—its diameter being about 2,600 miles. Rhea is probably the next in size, for observations of the length of time that it takes to disappear when passing into the planet shadow make it some 1,100 miles in diameter. Iapetus may be nearly as large. while Dione and Tethys are probably 700 or 800 miles in diameter, Enceladus about 500, Mimas perhaps 400, Hyperion 300, and Phoebe 150.

Small and faint as these bodies are, it is remarkable that in some cases we know their masses. Their mutual attractions modify one another's motions, and a study of these effects, in the skillful hands of Prof. Struve, has shown that the masses of Dione and Tethys are 1-20 and 1-120 that of our moon, while tiny Mimas contains but 1-2,100 as much matter as the moon—which is the smallest mass whose attraction has so far proved measurable by astronomical means. It gives a realizing sense of the magnitude of astronomical masses when we recollect that this mass, almost infinitesimal from the astronomer's standpoint, amounts to 35,000 millions of millions of tons—enough to form more than a million mountains of solid rock, each a mile high and ten miles around the base!

Titan, the largest of the satellites is also the most massive, being of nearly twice the mass of our moon, or 4,000 times that of Mimas—and yet this huge quantity of matter forms merely a satellite. The planet about which it revolves is more than 4,000 times as massive as Titan, and the sun 3,500 times greater in this respect than Saturn itself.

The Heavens

Our map shows the splendid group of constellations on the east and south—Orion high in the southeast with Taurus above and Canis Major below; and Canis Minor, Gemini and Auriga in the east—the last almost overhead. The southwestern sky, on the contrary is very dull. Cetus and Eridanus being among the least brilliant of the constellations. In the west are Pegasus, Andromeda and Aries, while Perseus is overhead, and Cassiopeia, Cepheus and Cygnus below him in the northwest. Draco and Ursa Minor are below the Pole. Ursa Major is rising in the northeast, and Leo in the east.



At 11 o'clock: Dec. 7
At 10½ o'clock: Dec. 15.
At 10 o'clock: Dec. 23.

At 9 o'clock: Jan. 7.
At 8½ o'clock: Jan. 14.
At 8 o'clock: Jan. 22.

At 9½ o'clock: December 30.

NIGHT SKY: DECEMBER AND JANUARY

The Planets

Mercury is an evening star all through December, but can only be well seen toward the end of the month when he sets at 6 P.M., and, though far south in Sagittarius, is visible in the twilight.

Venus is a morning star in Libra and Scorpio, rising between 4 and 5 A.M., and conspicuous before sunrise, though not nearly so much so as she was before she went so far south.

Mars is an evening star in Sagittarius, too near the sun to be well seen. He is in conjunction with Mercury on the 22d, but neither planet will be readily observable. Jupiter is in Pisces and crosses the meridian at 9 P.M. on the 1st and 7 P.M. on the 31st, so that the conditions for evening observation are exceptionally good.

Saturn is on the border of Gemini and Cancer, and, though not yet in opposition, rises at 7:30 P.M. on the 15th, and is conspicuous in the latter part of the evening.

Uranus is in Capricornus, setting about 8 P.M. and barely if at all observable. Neptune is in Cancer, about 5 deg. east of Saturn, and is observable in the latter part of the evening.

The moon is in her first quarter at 9 P.M. on the 1st, full at 7 A.M. on the 9th, in her last quarter at 1 P.M. on the 17th, new at 4 P.M. on the 24th, and in her first quarter again at 7 A.M. on the 31st. She is nearest the Earth on the 25th, and remotest on the 13th.

In her circuit of the sky she comes into conjunction with Jupiter on the 5th, Saturn and Neptune on the 13th, Venus on the 22d, Mars on the 25th, Mercury also on that day, and Uranus on the 27th.

On the 24th and 25th of December occurs a partial eclipse of the sun, which is remarkable for its extreme smallness. The penumbra, or outer fringe, of the moon's shadow just grazes the southern edge of the Earth, so that the eclipse is only visible in Antartica, south of the Indian Ocean. At some points the midnight sun will be eclipsed; but the eclipse will be very small amounting to 1-90 of the sun's diameter—the barest nick in the sun's limb. It is improbable that any human eyes will see the phenomenon.

Princeton University Observatory.
November 22nd, 1916.

The Production and Importation of Ammunition for Swiss Rifles

THE rifle ammunition most widely used in Switzerland is the so-called war ammunition, manufactured by the Federal Ammunition Factories at Thun. Canton of Berne, and Altorf, Canton of Uri. The cartridges are similar to the Remington and Mauser 7-millimeter products, with rounded "patched" bullets or with pointed bullets. The Swiss ordnance rifle has a 7.5 millimeter caliber. No other ordnance ammunition than that manufactured in the Swiss Government factories is permitted to be used in the official military rifles.

For private rifles, the so-called "stutzers," the war ammunition is almost exclusively used, because the caliber of the barrel and the cartridge chamber are especially made to fit this product. At all shooting competitions held in Switzerland, whether Federal, cantonal or municipal, the Swiss war ammunition is exclusively used, no other makes being permitted. The principal reason for this is that the target fields correspond with the degree of precision of the ammunition and of the weapons. Both kinds of cartridges, with rounded and pointed bullets, are still used, but the latter have the advantage of possessing a greater precision.

The ammunition for the ordnance pistol and revolver is also manufactured by the Government, and the use of or practice with any other make is strictly forbidden. For hunting purposes, however, some ammunition is imported into Switzerland. Before the war this came chiefly from Germany, because experiments have been made in that country in order to comply in every respect with the requirements of the Swiss authorities. Swiss hunters, as a rule, are very conservative in the selection of their ammunition, and when they have tried out a certain brand with satisfactory results it is difficult to induce them to try another brand.

For the sale of Swiss ordnance ammunition for rifles, pistols and revolvers, special shops are designated by the Government. In the cities and larger towns there are always several such shops. The importation and sale of any other kinds of ammunition are in no way restricted.

The Swiss ordnance rifle cartridges are sold at 50 centimes (9.7 cents) per 10 cartridges, but the actual cost of production to the Federal Government is said to be 11 centimes (2.1 cents) per cartridge. Pistol cartridges are sold at 96 centimes (18½ cents) a box, containing 24 cartridges. The cost of producing these is not exactly known, but it is said to be somewhat higher than the selling price. The stated reasons for selling ammunition not only without profit but even under the actual cost of production are two-fold: first, to encourage and promote the practice of shooting in the country; secondly, to use up and replace continuously the stocks of war ammunition and thus avoid their becoming useless as a result of long storage.

New Night Storm Signals

ON Octobcr 15th the Weather Bureau inaugurated the use of a new system of night storm signals on the Great Lakes, as follows: Northeast storm, two red lanterns, one above the other; southeast storm, one red lantern; southwest storm, red lantern above white; northwest storm, white lantern above red; hurricane or whole gale, two red lanterns with a white one between, in a vertical row.

The New Answer *to the* Servant Problem

She's leaving! Leaving her position—disgruntled; leaving you—discouraged. And you had just congratulated yourself on getting at last a maid who really suited, and who seemed satisfied to stay.

But—you have been all through such experiences time and again. You'll call the Employment Bureau and have them send around another girl. You'll hope for the best—and let it go at that, knowing full well that it will be a repetition of past experiences.

What are you going to do about it?

Listen:

Electricity will make it easier for you to get servants and to *keep* them—by making housework more attractive. And it will simplify your own work if left without a maid.

There's the Washer and Wringer to do the week's wash on a Monday morn, and the Electric Iron to follow it up in the afternoon of the *same* day.

There's the Electric Toaster to make appetizing toast at the table and to keep it crisp and warm.

There's the Electric Range rapidly coming into more general use for cooking through the attractive rates now being made for current in many parts of the country.

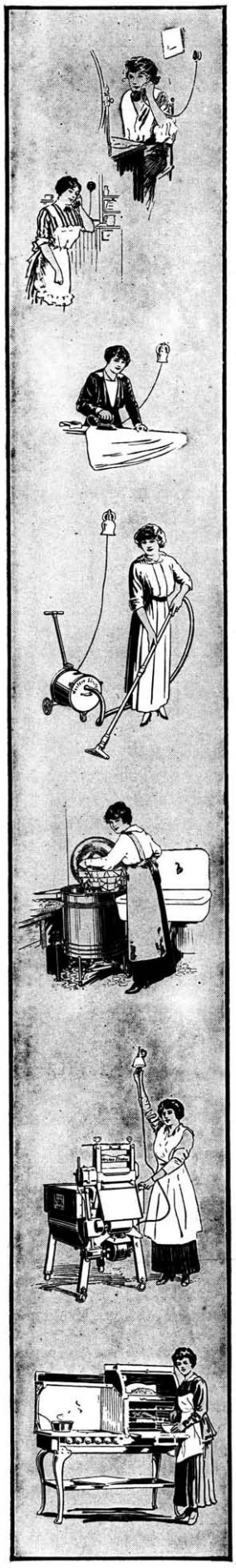
And after your electrically prepared meal is over, there is the Electric Dish-Washer to clear it away.

Then, too, there are the Vacuum Cleaner, the Fan, the Inter-phone and the dozen and one other conveniences—all to be had with the quality mark—Western Electric.

These devices are easy to buy and each one is an investment which soon pays for itself. Exclusive of the Electric Range, the cost of current to operate them all per month is less than your monthly bill for light alone. For while other necessities of life are *increasing* in cost, electric current is steadily decreasing.

If you have a servant problem in your home, why not find out now how electricity can help you solve it?

Write our nearest office today for your copy of Booklet No. 73-AG, "The Electrical Way."



WESTERN ELECTRIC COMPANY
INCORPORATED
195 Broadway, New York City
Houses in All Principal Cities of the United States and Canada

Western Electric

America's Electrical Week, December 2nd to 9th

Electric Heating in the Industries

(*Continued from page* 494)

strip on the edges of which insulating blocks are carried. These blocks are made of a compound which will retain its insulating qualities at the temperature to which they are subjected, and at the same time are strong enough to withstand rough service without cracking. Notches on the edges of the blocks make a winding form for the flat resistance ribbon, and the blocks serve further to insulate the ribbon from the metal supporter. The units are assembled in an iron frame and are insulated therefrom by blocks of the same compound. The frames, in turn, are provided with feet for mounting in the oven, and are made in standard forms for mounting on either the wall or floor. These heaters are available in capacities from 1.3 kilowatts to 12.3 kilowatts, and are standard for voltages up to 480. The temperature range for which they are suitable extends as high as 900 deg. Fahr. in the oven.

In most cases it is desirable automatically to maintain the requisite temperature in electrically-heated industrial ovens, although experience shows that there are cases where manually-operated panels are quite satisfactory. In some instances all the heaters are connected to and disconnected from the supply circuit in periods which will maintain the proper temperature; in other instances it is better practice to connect and disconnect a portion of the heaters; still in other instances the heaters should be grouped. In the case of direct current equipment, provision should be made for connecting the groups in series or in parallel, while in the case of alternating current equipment provision should be made for making "Y" delta connections of the heaters.

With the present state of development in electric heating, few if any commercial applications have been made of electric furnaces for melting brass. Yet manufacturers have reached a point where it is safe to predict that in a short while these devices will be available for commercial applications. And we have only to consider for a moment the millions of pounds of castings that are made from copper and brass every day to grasp the importance of this development to central stations. The conditions are favorable since with the electric furnace properly developed, the temperature can be held practically constant at the point best suited to the work; stack losses can be reduced to a minimum; and a non-oxidizing atmosphere can be maintained.

In one brass foundry which the writer has in mind, nearly 1,000,000 pounds of brass are melted every working day. From tests that have been carried out it is safe to estimate that this work can be done with a consumption of electric current not greater than 300 kilowatt-hours per ton. It is probably conservative to state that the net losses in the best brass foundries are not less than 1.2 per cent. From tests which have been conducted in melting brass electrically, it is safe to assume that these losses with the electric furnaces will not exceed .3 per cent, or a saving of .9 per cent. Now then, on the basis of melting 1,000,000 pounds of brass per day, the employment of electric heating should net a saving of 9,000 pounds; which means that out of 1,000,000 pounds of metal put into the furnace, the manufacturer would obtain 9,000 pounds more ingots. These ingots, say at 24.8 cents per pound, would amount to $2,232 per day. With a current consumption of 300 kilowatt-hours per ton and at a rate of 1 cent per kilowatt-hour, the cost of current for melting the 1,000,000 pounds of brass would be $1,500; and on the basis already mentioned there can be credited to the use of electric heat a saving of $732 per day, or per 1,000,000 pounds of brass melted. Furthermore, since the electric current is replacing some other form of fuel, the $732 saved would amount to considerably more when the cost of the usual fuel is taken into consideration.

There is a large field for the employ-

(*Concluded on page* 510)

One-ton G. V. Fleet of R. H. Macy & Company. These trucks have seen seven (7) years' service and are good for many more.

G. V. Light Wagons

Distinctive and Efficient

The G. V. Electric makes the *ideal* delivery wagon. It is always clean, practically silent, speedy, dependable and inexpensive to operate and maintain.

Low maintenance should be a question of years. Otherwise there is no economy. G. V. Electrics are long-lived. We know because we have hundreds in use that have stood the grind of from 7 to 14 years' service.

There are *no gears* in a G. V. "Where traffic is thickest G. V.'s are the quickest." Frequent starting and stopping does not injure *rotating* parts as it does the reciprocating parts of a gasoline car. G. V. simplicity means quick pick-up, traffic smoothness, traffic control. That's why a G. V. will "beat out" a 90 horse-power touring car in crowded traffic.

Frederick Loeser & Company bought their first G. V. in 1902. They now have forty-four.

Public utility companies use nearly 1000 G. V. Trucks. The lighter models predominate.

Used in 131 Lines of Business

The thousands of G. V. Electrics in service prove their popularity as well as their adaptability and economy. The 1,000 lb. and 2,000 lb. models are used by scores of

department stores, by bakers, provisioners, jewelers, florists, confectioners, laundries, interior decorators, banks, public utility corporations, etc.

It is significant that the Electric predominates in the fleets of the oldest and most experienced operators of motor delivery equipment. You can buy cheaper cars (mostly of the gasoline type), but you pay a premium in reserve equipment, due to break-downs, high repair costs and short life when you do so. Be guided by the experience of those who have invested millions in light G. V. Electrics. Place your order for at least one without delay.

Catalogue 101 will be sent you upon request; also names of users in your line of business. Write today.

Hundreds of G. V. Electrics deliver coffee, tea, groceries, provisions, etc. One baker uses 33.

G. V. Storage Vans are used in seven cities. Famous jewelers use them. Uncle Sam is a consistent buyer also.

General Vehicle Company, Inc.

General Office and Factory:
Long Island City, New York

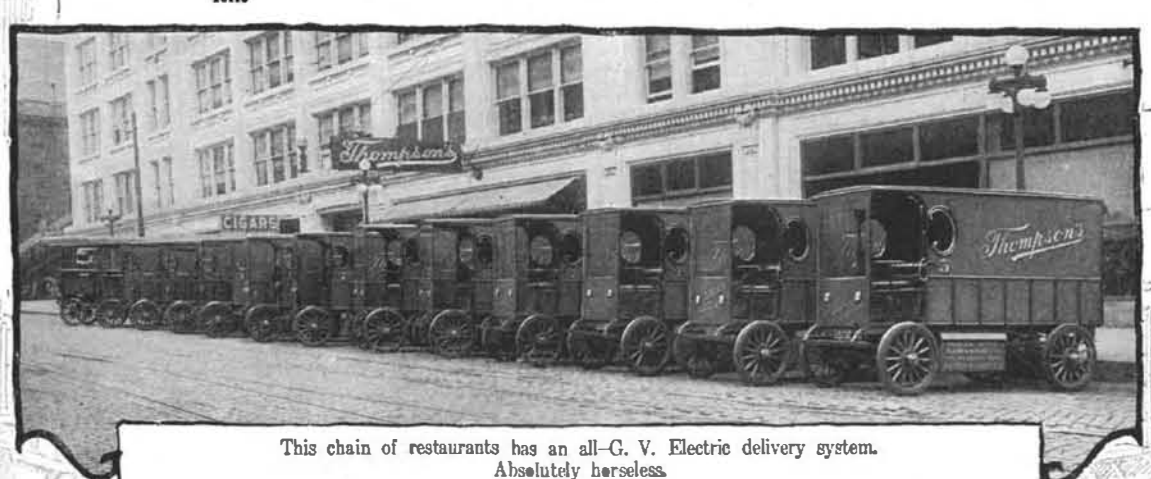
NEW YORK CHICAGO BOSTON PHILADELPHIA

Six Models: 1,000 to 10,000 lbs. capacity

Dealers in unoccupied territory are invited to correspond

"Do It Electrically"

16116



This chain of restaurants has an all-G. V. Electric delivery system. Absolutely horseless.

Electric Heating in the Industries

(*Concluded from page* 508)

ment of electricity in the process of sherardizing, which consists of baking ferrous metals in zinc dust so as to make them rust-proof. For example, there are many parts about an automobile which, when made of nickel-plated steel, rust very readily under ordinary weather conditions. Likewise it would be highly desirable in most cases if bolts, nuts, nails, tools, and other articles were treated in some manner in order to make them rust-proof. This protection, or sherardizing, can be best accomplished by baking the metal parts with zinc dust of the correct chemical analysis, at a certain predetermined and constant temperature for a period of time depending upon the thickness of the coat desired. The most satisfactory results with this process are obtained by the use of electrically-heated sherardizing ovens.

The importance of the sherardizing process cannot be overestimated. Take, for example, the many manufacturers who are making certain parts of their product out of high-priced non-corrosive material such as bronze and brass, when low-priced ferrous material could just as well be substituted provided it were properly sherardized. Electric heat renders sherardizing a comparatively simple process by the use of an electrically-heated revolving oven mounted on trunnions that are supported on pillow blocks. Typical ovens measure 40 by 24 by 24 inches, inside dimensions, and call for an input current of 53.5 kilowatts for about three hours, and 13.5 kilowatts for three to four hours. Smaller ovens measuring 10 by 10 by 17 inches, inside dimensions, call for a current consumption of 15 kilowatts for three hours and 5 kilowatts for three to four hours.

In establishments where there is a considerable amount of gluing to be done the use of electric glue cookers and pots does much to enhance the efficiency of the workmen. The advantages of self-heated, portable glue pots are immediately obvious when electricity is the source of heat. The most popular of these pots are generally of two types: the jacketless and the water-jacketed kind. The former is of cast aluminum, except in the smallest size, chosen for its high thermal conductivity. The walls of the pot distribute the heat evenly and prevent overheating. Only one heat is provided, and where the line voltage is fairly uniform, and quick initial heating is not imperative, this style is much in favor. The water-jacketed style consists of a sheet aluminum glue vessel and a cast iron water bath. Two heats are provided: high heat for quick, initial heating; and the low heat, for maintaining the temperature of the glue.

Establishments using large quantities of glue obtain better results by preparing the glue in one or more large central cookers from which it can be transferred to small pots and kept at the proper temperature for use at any point desired. The electrically-heated glue cooker used in connection with individual electric glue pots makes an ideal equipment. The cooker, of course, is thermally insulated.

One might go on almost indefinitely in describing the divers applications of electric heat in the industries, for there are few heating operations where electricity cannot be applied. Liquid heating tanks, melting tanks, oil tempering baths, pouring pots, linotype and monotype pots, steam and hot water boilers, circulation heaters, soldering irons, pressing irons, burning in irons, stoves and bot plates, wax knife heaters, matrix driers, driers of all kinds, room heaters, hot air blowers, bacteriological incubators, palette ovens, and laboratory furnaces are but a few of the tried-and-found-successful applications of "white coal." Still, the surface has been barely scratched: there is far more promise in the future of electric heating, than in the present.

Cost of Electric Light

By F. C. Meyers

MOST people consider electric light rather as a luxury and more expensive than other forms of illumination. The following results of an investigation by The Society for Electrical Development shows the exact opposite to be true provided the equipment is modern and in good repair.

What is commonly thought to be the cheapest light is candle light. A recent test of six candles showed that for one cent only 2.68 candlepower hours were obtained.

If electricity for lighting costs 8 cents for a kilowatt a 20 watt lamp can be lighted for 50 hours for 8 cents. The efficiency of a 20 watt incandescent is a candlepower for 1.17 watts. Thus a 20 watt lamp will provide about 17 candlepower. It will burn 50 hours for 8 cents or 850 candlepower hours will cost 8 cents. One cent will buy 103 candlepower hours or 39 times as much light as can be obtained from a candle for one cent.

Ordinary kerosene lamps with kerosene at 15 cents will give 72 candlepower hours for one cent. Figuring electricity at 8 cents a kilowatt hour as above we find 72 candlepower hours for one cent balanced against 106 for electricity, or a margin of 34 candlepower hours in favor of electricity.

With an open gas flame and gas costing $1.50 a thousand cubic feet, one cent will buy 29 candlepower hours. As noted for this price electricity will provide 103 candlepower hours. Thus balancing gas against electricity we find the margin to be 77 in favor of electricity.

Gas mantles have become very popular and with the best mantles one cent will buy 114 candlepower hours. This is only true, however, when the mantle is new, the globe clean and the gas pressure just right. Under ordinary circumstances, however, all these conditions are not correct for this result to be obtained. But even if this amount of light is obtained the margin in favor of the gas light is only 8 candlepower hours, which is practically negligible.

Electrical Invasion of the Home

(*Continued from page* 502)

apparatus, the former costing about twenty-five dollars and the latter from ten to thirty according to size. They run on so little current that the cost is negligible.

Parents who get up in the small hours of the morning to heat water with which to heat a nursing bottle, will appreciate the nursery milk warmer. This device, which uses 440 watts of current and does its work in three minutes—which, in other words, will heat 20 bottles at a cost of two mills per bottle, has a coil which contains the heating element. The bottle stands in the coil, and coil and bottle together are placed in a specially made receptacle in which water is kept. The milk heats evenly, all through the bottle, in the minimum of time and without trouble or danger of fire.

Electric irons for ironing clothes are gradually making headway in private houses. The electric iron is smokeless, odorless and absolutely clean at all times. It stays at the heat desired for as long as desired. Independent of a stove, ironing can be done in the coolest room in the house. They come in all sizes, from the tiny travelers' iron, which ladies can carry for hotel use on fine laces, handkerchiefs, ribbons, etc., using 200 watts of current, up to big ten-pound laundry irons using 700 or more watts of current. Prices range from $2.50 to $10.00, according to size and style. They can be had also as fluting irons and even as silk hat irons, tiny little tools, the heating elements of which are so small as to need lamps in circuit with them when used.

Curling irons for milady's "front" and "marcel waves" which stay hot as long as desired and electric hair combs, which are warmed to just the right degree to dry shampooed hair, are among the toilet con-

(*Continued on page* 514)

The Master Workman —

The great builder is Electricity. With its aid your engineers daily accomplish new feats of construction and operation. Enormous bridges, great dams, immense ships, docks, dikes and tunnels are carried to swift completion—*Electrically.*

Electricity controls the lock gates of the Panama Canal: Electric locomotives tow the great ships through. The traffic of the East and West crosses the backbone of our continent on electrically hauled trains.

The cloth of your suit was undoubtedly woven by an electric loom, cut by an electrically driven knife, and put together on an electrically driven machine. In an ever widening field this greatest SERVANT of mankind is performing the labors of men's hands and tiring muscles.

In the development and improvement of the ways of applying the forces of Electricity, it has been the distinction of the General Electric Company to play a leading part. Through its great Research Laboratories, engineering organization and extensive manufacturing plants, ALL that has been learned in each field of electrical endeavor has been applied to the furtherance of every other field.

When at the snap of a switch your room is flooded with light; when a street car carries you to your destination; when any of the conveniences or comforts of electricity make your day's work lighter, brighter and more enjoyable, remember the part the General Electric Company has had in making these things possible.

And when you have any problem of light, heat, power or transportation, or when you buy any piece of electrical apparatus—remember the experience and knowledge summed up by the monogram G-E and that it stands for

"The Guarantee of Excellence on Goods Electrical"

GENERAL ELECTRIC COMPANY

SCHENECTADY, NEW YORK — SALES OFFICES IN PRINCIPAL CITIES

6590

Electrical Invasion of the Home

(*Continued from page* 512)

veniences which a six-foot cord and plug make available to any one who has electric current. They use an inconsiderable amount of current—less than the usual electric bulb—and are inexpensive, a whole set being obtainable for ten dollars and individual units for from $2.00 to $5.00.

The portable electric room-heating stove, or "glower" is a special adaptation of electricity particularly useful in fall and spring, in sick room, nursery or bath room. It consists of one or more special electric light bulbs—perhaps it is more true to say electric *heat* bulbs, since their purpose is to radiate heat and not light. These, mounted in a container or base, form the portable stove. "Two glower" heaters require 500 watts of current, and therefore can hardly take the place of oil, gas, or steam heat as a permanent installation. But it is often necessary to warm up a chilly room suddenly when ordinary heat sources are not available, and no one who has taken a cold plunge on a chilly morning and then dressed in front of a radiant electric heater but will agree that the penny for ten minutes' heat has been well spent!

As there is no flame in these heaters there is no danger of fire. Damp clothes can be laid directly on the heater without danger, and, if sentiment can have a momentary place in so practical a story, the fact that the soft heat is accompanied with a flood of light makes these pieces of apparatus decidedly cheerful companions.

The public is already well advised as to the comfort, durability and necessity of the device which sucks the dirt out of carpets, hangings, pillows and mattresses and deposits it in a bag for removal, in place of the old and tiresome methods of sweeping and dusting. The majority of vacuum cleaners are electrically driven. Many new houses have electric air pump motors installed in the basement, and the pipes through which the dirt is to be sucked permanently placed in the walls, with an outlet in every room. The ordinary cleaner, however, which "plugs in" to the ordinary lighting circuit is less laborious to use than a broom, and the result is a real, not an apparent cleanliness, since the dirt is removed from the interior as well as the outside of all carpets, rugs and curtains. The cost of such apparatus varies from twenty-five dollars to a hundred or more. Current consumption is very small and the comfort to the housecleaner beyond words.

Sewing room, laundry, ice cream freezer, scullery, all have special electric conveniences, in the form of motors which drive sewing machine, washing machine, wringer, freezer and clean knives and polish silver with the minimum of band labor. The cost of operation is not felt in the monthly electrical bill, and the saving of muscle is incalculable.

Ask any woman who sews on a sewing machine if she would run the pedal for five cents a day, and judge by her answer whether it is worth while to run a sewing machine electrically at a cost of a cent a day or less. Sewing machine motors come in many styles—some attach in place of the hand wheel, others go underneath and are controlled by a movement of the pedal, metamorphosed from a power source to a controller, still others are screwed to the sewing machine table and belted to the machine proper.

Finally there is electrical ornamentation. Whether it be a string of colored bulbs for the Christmas tree, a basket of electrical fruit, glowing with beautiful colors for the dining table, or a hanging basket of electrically lit flowers, one fact stands out above all others. Electric ornamentation is safe. It needs no flame. It gives light, in many colors, effects of many kinds, at small cost, both for installation and operation, and all without any change in house wiring, any danger in

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Electrical Invasion of the Home

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careless hands, or any possibility of dirt or grease, as is the case with candles.

The user of electric light has found one great comfort of the silent, noiseless, wonderful power which comes to him invisibly on wires. Who possesses it in bis house, and does not use it for some of the thousand other purposes it serves so well, is robbing himself of one of the greatest boons this marvel and the civilization which produced it, can give—personal comfort in large measure, at minimum expense and without danger.

Electrification of Steam Railroads

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under steam operation was a change made to electricity for tbe purpose of increasing profits. The reasons which have stimulated the electrification of steam railroads, as outlined by the Committee, may be summarized as follows: First, it meets the requirements of operations under difficult physical conditions, such as those occasioned by the underground terminals, tunnels or heavy grades; second, it takes advantage of available water power in districts in which the cost of coal for steam operation was relatively high; third, it meets the requirements of the increasing suburban traffic in cases where frequent and rapid services with comparatively short runs between stops is necessary, or in cases where terminal facilities proved insufficient for the handling of service by steam operation; fourth, it increases the capacity of stub-end terminal stations without physical enlargement, a result which is accomplished by reducing the number and extent of idle movements in the station and through its approach switches; fifth, it provides a means of conducting experiments for the purpose of determining the effect of electrical operation in stimulating traffic and, sixth, it meets the competition of electrical suburban or interurban service.

The above summary is important in clearly outlining to the reader the directions in which an expansion of this method of traction may be looked for. It shows that, while the Railroads may be expected to adopt it in special cases in the future as in the past, the method cannot be expected generally to supersede steam locomotive service until such time as the development of the art makes it practicable to electrify at such a low first-cost that no new net burden will be placed upon the railroads; either the direct savings must produce a sum sufficient to pay the annual fixed charges required upon the new capital invested, or the collateral advantages produced, must in effect do so before electrification can become a sound business proposition and be indefinitely extended to other than special cases.

Brief reference to the most prominent existing steam railroad electrifications in this country will perhaps be of interest. They cover about two thousand miles of track, out of 240,000 miles in the country—a small proportion, of course, but full of interesting possibilities for the future.

The first example, the Baltimore & Ohio Railroad, in Baltimore, has already been alluded to; its object was to eliminate smoke in a long tunnel.

The next is a very extensive electrification for suburban traffic on the Long Island Railroad; it was undertaken primarily to eliminate smoke in its city terminals but was extended over a long network of lines to make the handling of a dense traffic more successful.

Then came the electrification of the large New York City terminals of the New York Central and of the Pennsylvania Railroads; both undertaken by reason of underground operation within a city, but extended to considerable distances beyond for operating reasons. The New York, New Haven & Hartford Railroad, operating into the Grand Central Terminal, was also forced to electrify and found later that to obtain any return

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Electrification of Steam Railroads

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at all upon the investment it was necessary to carry the electrification to New Haven, 70 miles out, and to adopt one form of motive power for this entire division.

A number of tunnel lines other than the B. & O. have been electrified, notably the Cascade Tunnel on the Great Northern Railroad, the St. Clair Tunnel of the Grand Trunk, and the Detroit Tunnel of the Michigan Central. Both of the latter are under the St. Clair River and were electrified to eliminate danger from smoke and gases and to increase the capacity of heavy grade tunnels.

Another interesting installation is that of the Pennsylvania Railroad at Philadelphia, undertaken primarily to increase the capacity of its Broad Street Station where traffic is very heavy and the congestion at times serious. This is a stub-end terminal approached through a restricted track throat, and it was believed that by using motor-car trains for the suburban service the capacity of the station could be largely increased, and thus quick relief for the public would result, instead of waiting for a number of years for improvements which would follow a physical enlargement of the station by the purchase of occupied property and the closing of city streets. This relief is accomplished by eliminating the so-called "light engine" movements through the throat of the yard. Thus, a steam locomotive train entering the station must back out or be pulled out by another locomotive, in order to reverse the movement; with an electric motor-car train, a number of these idle movements are eliminated, as the train comes in and goes out again without any change in its motive power. Incidentally, the electrification of this suburban service, which is on a heavy grade for a distance of 20 miles out of the city, has effected a shortening of the scheduled time and otherwise conduced to the comfort and attractiveness of the service to the patrons of the Railroad.

Another recent electrification, constituting the heaviest electrified service to date in the world, is that of the Elkhorn Grade over the Allegheny Mountains on the Norfolk & Western Road. While the length of the line is only thirty miles, its grade is heavy (two per cent against traffic), and the density of coal traffic is very great. In order to move a 3,000 ton train up the grade it required three Mallet compound steam locomotives and the running speed which could be made was only about seven miles per hour. The actual time required to run over the divisions was variable and great, because of frequent delays to steam locomotives while taking coal and water and because of the congestion to the tracks caused by slow speed, especially through the single track Elkhorn tunnel. To relieve this congestion, the Road decided to electrify and now hauls 3,250 ton trains with two electric locomotives up the grade at a speed of 14 miles per hour instead of seven as before; and, because of eliminating many locomotive delays, an electric engine now makes from three to four times as much daily mileage as the steam engine did formerly. In this installation the electric motors on the locomotives are made to act as generators, returning current to the line on the down grades and thus holding the train at a uniform speed without applying mechanical brakes to the car wheels.

The trunk-line electrification of the Chicago, Milwaukee & St. Paul is the latest and most startling development in electric traction. This road is engaged in electrifying 440 miles of its main line, crossing three mountain ranges in Montana and Idaho, the greatest length of electrified main line on any road in the world. About one half of this distance is now in successful operation. Both freight and passenger trains are hauled at a considerable gain in speed on the heavy grades, and it was found last winter that operation was greatly facili-

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tated during the very cold weather, as at such times trouble is always experienced in the poor steaming of locomotives. Electrification of this line was primarily undertaken to produce operating economies, as water power is available to replace an expensive and inferior grade of coal for steam locomotives as a source of energy. No figures for the relative economy of the two kinds of traction are, however, yet available from this installation and it will be interesting to see if long lines with such light traffic can be electrified to produce such economies as will pay the charges on capital invested in the electrification and leave a profit above this.

Strategic Moves of the War

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blow must first be aimed, and delivered, at Adrianople. The distance between the two cities is about 160 miles, the roads are few and very bad, the country is rough and broken with many streams running across the line of advance; in other words, this is a very difficult country from the military point of view.

The distance from the Cernavoda-Constanza line to Adrianople is about 225 miles. The line of advance would lead over many water courses and at least one range of mountains. There is but one railroad running parallel to the line of advance from that direction and then, only as far as Varna, less than two fifths of the way. The country roads are bad when at their best; in winter and in bad weather they are almost impassable.

This advance would have to be made entirely through hostile territory. This means an active enemy in front, an equally active and even more dangerous enemy on the right flank (the left flank would naturally rest on and be protected by the Black Sea), a hostile population everywhere and all the railroads, highways and general topography of the country favoring the operations of the defenders in front and especially on the flank of the advancing army.

The distance from the Struma to Adrianople is about 210 miles. In a "drive" from that point toward Adrianople, an advancing army would be exposed to the same dangers as in the case of the one from the Dobrudja, substituting the left flank as the exposed flank of the Saloniki advance, for the right flank of the advance from the Dobrudja. The obstacles encountered and the generally unfavorable local conditions would be very similar in both cases.

At present writing the forces of the Central Powers are still within gun shot of Monastir and are also in touch with Allied lines on the Struma. Mackensen is still fighting his way successfully into the plains of Wallachia. I will venture to say now, that no drive on Constantinople is under consideration by Russia at this time, and that there will be none from either the Dobrudja or Saloniki, until certain very important military events of a decisive nature shall have taken place. If sometime in the future I should read that Falkenhayn had been driven out of Rumania and all the mountain passes had been secured against the possibility of future invasions; that Mackensen and all the Bulgo-German forces in the Dobrudja and in eastern Bulgaria had been pushed westward beyond Sofia, in other words, that Bulgaria had been crushed; and if at the same time, I read that the Allied forces in Saloniki had felt justified in pushing forward from their base and had succeeded in establishing their advanced line somewhere north of Uskub, then, but not until then, would I expect to hear that a large Russian army was concentrating in the vicinity of Adrianople. But even that would not necessarily mean the capture of Constantinople. Some of these things may come to pass this winter, but I doubt it very much.

Ruth Law and Her Remarkable Flight from Chicago to New York

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have Carstrom's military biplane equipped with a 200-horse-power engine and carrying a sufficient supply of gasoline to make a non-stop flight possible. The pilot sits in a comfortable cockpit. Miss Law's machine, in sharp contradistinction, is a Curtiss biplane more than two years old, of the pusher type and with the single seat projecting out in front of the lower plane, offering practically no protection to the aviator. Because of Miss Law's earlier practice and familiarity with the Wright biplane, her present machine has been equipped with the usual Wright control levers, and with an auxiliary tank to bring the fuel capacity up to 53 gallons. As for her instruments, they were limited to absolute necessities as compared to the luxurious equipment of Carlstrom's machine. Then again, it is well to recall the elaborate preparations that were made for Carlstrom's flight, compared to the sudden and certainly unostentatious start of Miss Law.

But it is not our intention to discredit the magnificent flight made by Carlstrom which has only been excelled in this country by that of Miss Law. Still, even if both had scored a similar record our greatest admiration would have gone to Miss Law, first, because she is a woman; and second, because of her skill and daring in piloting her little Curtiss "pusher" over so great a distance. Nevertheless, the victor is Miss Law, who has broken the two records made by Carlstrom; has established a new American record for cross-country flights; has broken the world's record for continuous flight by women pilots; and, most important of all, is, for the moment at least, America's premier aviator.

NEW BOOKS, ETC.

RAILWAY ORGANIZATION AND MANAGEMENT. By James Peabody, Late Statistician, Atchison, Topeka & Santa Fe Railway Company. Chicago: LaSalle Extension University, 1916. 8vo.; 263 pp.; illustrated.

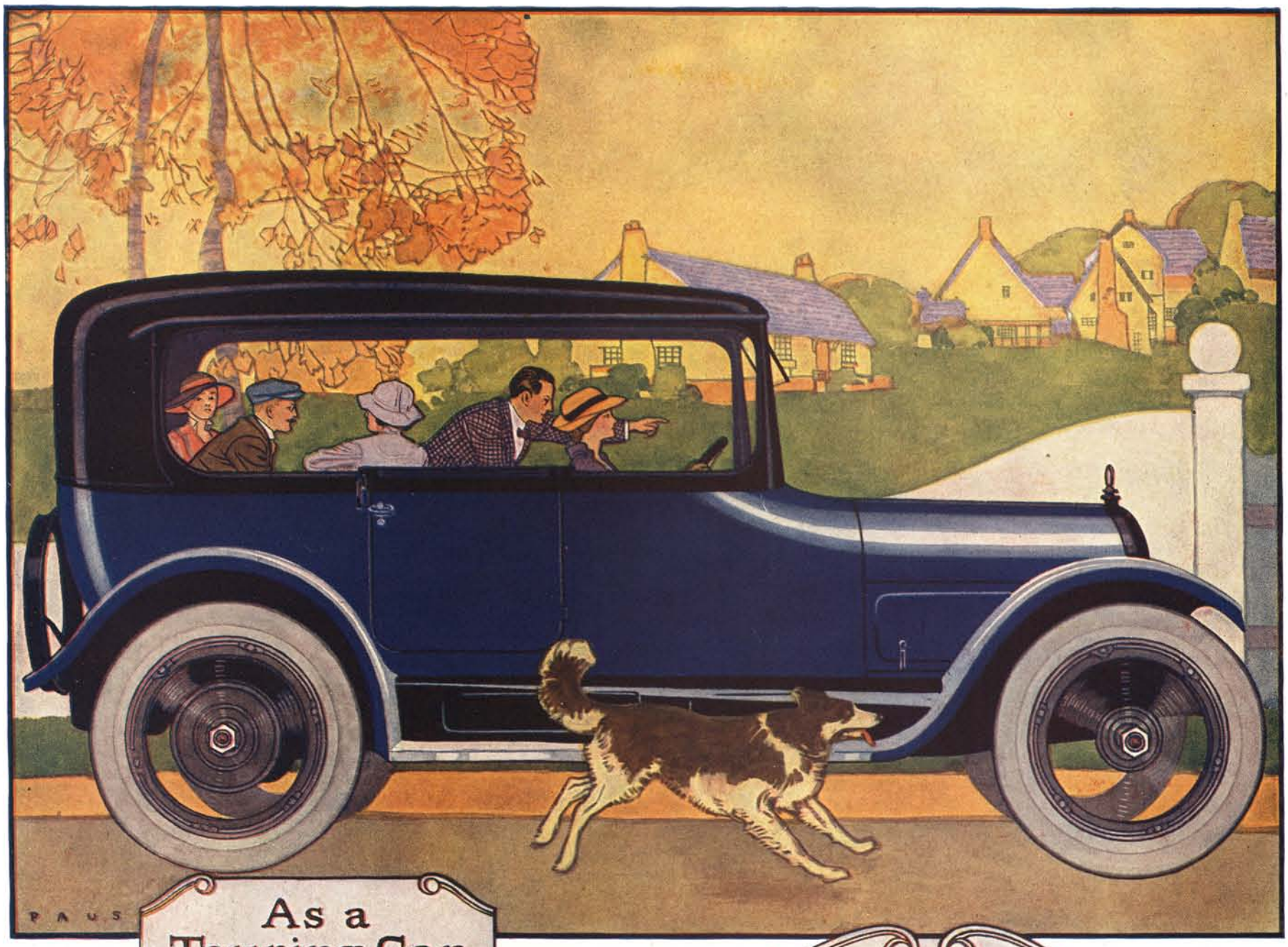
Forming part of a study course in interstate commerce, this text explains in detail the system upon which efficient management of transportation is based; the general scheme of organization is set forth; the purposes and performances of its subdivisional bodies—the departments of administration, engineering, operation, traffic, accounting, etc.—are patiently and skillfully unfolded to the student, and he soon comes to see that what the casual observer condemns as red tape is really the bond that holds a complex and literally human machine together, enabling it to accomplish its modern miracles of speed, safety and efficiency. Railroad problems, whether represented in the foolish lawmaker or the scarcity of wood for ties, are by no means slighted; even such by-paths as pensions and the education of apprentices are profitably wended; in short, the work is an ideal introduction to the business of railroading, illustrated by actual and typical examples from successful systems.

AMERICAN BOYS' BOOK OF ELECTRICITY. By Charles H. Seaver. Philadelphia: David McKay, 1916. 8vo.; 365 pp.; illustrated. Price, $1.50 net.

The author knows how to interest boys in whatever he has to tell them; without in any way seeming to "write down" to his readers, or to preach at them from a pedestal, he makes his meanings clear in conversational language. From simple experiments with magnets, needles, iron filings and corks, the boy finds himself absorbed in building a "thunder house;" it is easy to pass on to the making of batteries, the principles of the electric bell and the arc lamp, and the fabrication of electric generators and motors. A large section is devoted to wireless telegraphy, and there are chapters on private electric plants and the making and installing of lamps and fixtures. The book offers a great incitement to the cooperation of brain and hand in accurate, useful and fascinating work, and this in its turn goes a long way toward making the raw material of the boy into the finished product of the skilled man.

HOW TO MAKE SHOW CARDS. By Charles A. Miller. Boston: The Spatula Publishing Co., 1916. 8vo.; 131 pp.; illustrated. Price $1.

This is a meritorious little treatise in paper covers, which puts the novice in the right way of handling pen and brush in artistic lettering. The chapters on the geometry of letters are a veritable first aid to the bewildered beginner; layout and spacing, inks and paints, color combinations and the catch phrase are other matters considered, while an appendix by W. A. Thompson shows actual work executed by marking and shading pens and brushes.



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