

## AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

New York, October 23rd, 1895.

The 100th meeting of the INSTITUTE was held this date at 12 West 31st Street, and was called to order by Vice-President Francis B. Crocker, at 8 P. M.

THE CHAIRMAN :—[Vice-President Crocker.] Gentlemen, the Secretary has certain announcements to make in regard to routine matters.

THE SECRETARY :—At the meeting of the Council held at the office of the INSTITUTE this afternoon, the following associate members were elected :

Name.	Address.	Endorsed by
BYRNE, HARRY	Organizer, The National School of Electricity, Chicago, Ill.; residence, 5620 Drexel Ave.	C. C. Haskins. Harry H. Hornsby. Arthur Frantzen.
COLES, EDMUND P.	Special Tester, General Electric Co., Schenectady, N.Y.; residence, 240 Union St.	John B. Blood. Thorburn Reid. W. J. Davis, Jr.
COLLES, GEORGE W., JR.,	Draughtsman, Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.	Wm. E. Geyer. Henry Morton. Henry Floy.
CRAWFORD, L. G.	Sup't, Repair Dep't Gen'l Electric Co., Chicago, Ill.	Frank H. Dorr. Clare F. Beames. Chas. P. Steinmetz.
SHONNARD, HAROLD W.	Designer and Foreman, The Electric Self-Playing Piano Co., 333 W. 36th St., New York City; residence, 23 W. 43 St., Bayonne, N. J.	T. D. Bunce. Frank Martin. Robt. Lundell.
WALKER, ARTHUR F.	Sup't and Electrical Engineer, Edison Light Co., Grand Rapids, Mich.	Frank B. Rae. Chas. Wirt. W. S. Barstow.

Total, 6.

THE CHAIRMAN :—I have to announce officially, what you all know personally, the fact that one of our most distinguished members and past officers was accidentally killed by the agency

which he was most familiar with, and that owing to the unavoidable absence of Dr. Duncan, who has interested himself in this matter, I am called upon to take the Chair. Dr. Duncan has very appropriately selected Mr. Thomas D. Lockwood to prepare and to present to you suitable resolutions in regard to the death of Franklin Leonard Pope, Past-President of the INSTITUTE. I will now call upon Mr. Lockwood to present these resolutions.

MR. LOCKWOOD:—MR. CHAIRMAN: It seems to me exceedingly fitting that before proceeding with the regular order of business, the INSTITUTE, as a body, should recognize that its duty, albeit a melancholy one, is to consider the sad event you have announced, and to pay its sorrowful but sincere tribute of honor and affection to the memory of our lamented Past-President and distinguished fellow member, Franklin Leonard Pope.

We must all deplore very much that thus early in the season of 1895 and 1896, we are under the painful necessity of recording the loss of one whom we have known and respected for so long—and yet, alas, for so short a time. I have been honored with Mr. Pope's friendship for some twenty years, and for ten years before the beginning of that period, I knew of his name, reputation and abilities, and I had set before myself, his example, as one well worthy of emulation in the career I hope to achieve.

It does not appear to me that this is the proper time to recount biographically, his life-story and work, since I am well assured that that will be done for the archives of this INSTITUTE by hands more skilful, and by tongues more eloquent than mine; but I cannot refrain from briefly testifying for myself, as a private citizen, a brother in profession and a fellow member and associate in this INSTITUTE, to the high sentiments of regard and admiration which from the earliest moment of our several years of acquaintance I have entertained and cherished for Mr. Pope, and the heavy and crushing sense of personal loss which has weighed upon me since I first read the sad news. And yet, Mr. Chairman and gentlemen, I welcome the intensity of the personal loss of which I have spoken, because I feel and I am convinced, that by it I am enabled in some measure the more truly to sympathize with the incomparably deeper sorrow of his family and kindred.

The life of Franklin L. Pope, as we all know, was an essentially busy one. It was one of constant and unremitting toil. When I first heard of him I was but a boy and he was comparatively a young man; but even then he was in the forefront of the work, and he was chief of exploration for the Russian-American Telegraph, which the Western Union Telegraph Company at that time had in process of construction, under the belief that the transatlantic cable could never be successfully laid. His toil, however, differed from that of the majority of mankind, in that it was three-fold, for not only did he toil to acquire and accumulate knowledge, but he also toiled in the utilization of

knowledge, and furthermore, and I think this was better than all, he always toiled with the glad hope of imparting knowledge, and in all of these three varying methods he toiled to the end, and we can truly say, he veritably "died in the harness." We may well sorrow as a body that he was not spared to work longer or to more fully enjoy the fruitage and harvest of the seeds which he has ever labored to sow, and the young growth of which he ever labored to prosper.

Those of us who had the happiness of a close intimacy with Mr. Pope will bear me out when I say that we shall remember him always as showing the kindness and genial spirit of a true friend; as being one who revered the right; endeavoring always to do his duty as he saw it; and as possessing, in addition to marvelous ability in many directions, and great powers of generalization, analysis and expression, a large share of modesty, that inherent attribute of true genius and talent. Employing the words of the inspired writer, we then may truly say that "a prince and a great man" has been taken from us, and I am confident that every member of this INSTITUTE will regard it as a privilege to be associated with the expression of our sorrow and our sympathy with the bereaved family. With this confidence, Mr. Chairman, I have therefore a sad satisfaction in presenting resolutions which formulate such expression, and in moving their adoption by the INSTITUTE.

These resolutions are as follows :

*Whereas*, the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS has heard with heartfelt sorrow of the sudden death by a lamentable accident, of its Past-President, Franklin Leonard Pope; and

*Whereas*, we, the members, Council and officers of the INSTITUTE desire to express our profound realization of the bereavment we have sustained, and the sincere grief we experience, and to record in fitting terms our keen appreciation of the great worth and high qualities of our fellow member; his eminent services to our organization; and his able, unwearied and successful work in applying electrical energy to many useful purposes; it is therefore

*Resolved*, that by the death of Mr. Pope, called away in the full fruition of manhood and the meridian vigor of intellect, the profession at large has suffered an incalculable loss, and the INSTITUTE has been deprived of a most distinguished and valued member, and a wise and sagacious counsellor, endeared to many members by long, pleasant and affectionate intercourse, and esteemed and respected by all, no less for his kindly and warm-hearted nature and dignified simplicity of character, than for his universally acknowledged genius and great ability.

*Resolved*, that we hereby express the poignant grief wherewith we contemplate the sad event which has taken from us one who, whether in the earliest days of our association, co-operating in its successful establishment, urbanely and efficiently presiding as our chief Executive Officer at business and social meetings, discreetly and judiciously performing the unassuming duties of a member of the Committee of Editing, or in the capacity of an individual member serving the interests of harmony and stability, has uniformly had the dignity of

the INSTITUTE at heart, and has assiduously, cheerfully, and faithfully labored for its welfare ; and while we sincerely mourn the loss of an associate so eminent and useful, thus suddenly withdrawn from the activities of this present life, we more earnestly grieve for the parting from a friend so sincere, faithful and true.

*Resolved*, that we extend to his stricken family our tenderest sympathy, in this, the hour of their affliction, and that in testimony thereof a copy of these resolutions be forwarded to them.

*Resolved*, that these resolutions be appended to the minutes of the Council and be published in the TRANSACTIONS of the INSTITUTE.

The resolutions were unanimously adopted.

THE CHAIRMAN :—The regular business of the meeting is the reading of papers. The first paper is by Mr. Hermann Lemp, Jr., on the “Local Annealing of Hard Faced Armor Plates.”

## LOCAL ANNEALING OF HARD FACED ARMOR PLATES.

BY HERMANN LEMP, JR.

Every one is now more or less familiar with the Thomson Electric Welding process, which in past years has been introduced into almost every metal industry, in one shape or another. This process created a new field in the technical application of currents of large volume and small E. M. F., a field which, while it was primarily intended for welding, naturally suggested a number of other applications to so fertile an inventor as Prof. Thomson; and so it happened that early in its fundamental inception, the use of large currents was contemplated to be utilized for heating plain metal bars or parts of sheet billets, etc., for forging purposes, to rivet, upset, to temper or withdraw the temper, or to be worked upon in any well-known manner while being kept heated by the current.

It has been the good fortune of the writer to lately work out one of these novel applications, and since the literature concerning this branch of electro-technics is somewhat limited, he has thought it advisable to bring an account of the same before the INSTITUTE.

One of the latest advances in the making of protective armor for battle-ships, or even forts, has been the introduction of what is known as the Harvey process. For those not conversant with the latter, I will briefly state that it consists in taking an ordinary low carbon steel plate and introducing an additional percentage of carbon into the surface metal, thus changing the crust to the depth of about an inch, into a steel resembling tool steel. A plate thus treated, is lastly water-hardened, similarly to an

ordinary tool, and by experience has shown to offer, under equal conditions, more resistance to the impact of a projectile than any other armor known, and therefore we will take this as an illustration of hard faced armor. The extreme hardness of the surface of a Harvey plate, while exceedingly valuable in preventing projectiles from piercing it, has a disadvantage when it is required to be pierced by a drill and tap. Such holes may be required either for fastening ladders, swivels or other appliances to the hull of the vessel, or to fasten T flanges supporting the deck to barbettes or turrets.

The methods heretofore used to produce these holes were principally two :

1. To protect the surface of the plate in patches or strips, to prevent carburization, wherever holes were expected to be drilled.
2. To make accurate drawings and patterns of each plate beforehand, to which all holes are drilled before plate is hardened.

Plan No. 1 was practiced in the United States until it had to be abandoned. In practice it was found that numerous alterations in construction, errors in either draughting-room or mills, made it necessary to pierce holes where no provisions for annealing were made. It also happened quite frequently, that the method for prevention of carburization did not always work satisfactorily, and while white paint indicated well enough where soft metal was expected, very often hard metal was actually found. Hence it was patent from the first that some process was needed to rectify errors of this kind. Experiments were then made with the oxy-hydrogen blowpipe, or the electric arc, to anneal such spots as required to be drilled, and numerous mechanical devices for drilling, with drills of every design and method of tempering, were tried, until it seemed that the case was without a remedy.

It was at this stage that the problem was referred to the Thomson Electric Welding Co. of Lynn, and experiments were immediately undertaken to solve it. The process and apparatus necessary to carry it out, all resulting from the experiments undertaken, will be described presently.

The second method, which is used in England, has the advantage over the first, that there is no difficulty in carrying it out, provided there are no alterations made, and no errors committed. The present method of construction seems to be, to make, beforehand, a complete *model* of the vessel to be built; then make

accurate drawings and full-size patterns of every plate, giving the exact location of every hole. These are then bored, tapped and countersunk to a depth of approximately  $\frac{5}{8}$ " and of a much larger diameter, filled with clay, and then the plate as a whole is heated and hardened with water. (See Fig. 1.)

This method works apparently all right, although in spite of drawings and models, errors are made. There is no doubt, however, that it is a slow and very costly method of working, and would hardly ever be resorted to in the United States.

From the above it seems clear that there has existed a need for a process by means of which isolated spots, regardless of location, might be annealed so as to permit drilling and tapping.

If, by sending a current of large volume through any spot thus to be treated, the spot is brought to a temperature of approximately 1000° F., there can be no doubt that the temper has been withdrawn. Experiments carried out to that effect at once

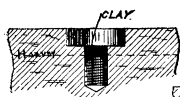


FIG. 1.

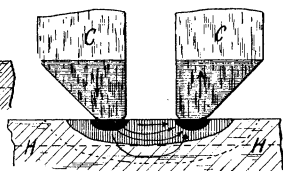


FIG. 2.

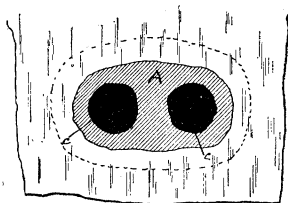


FIG. 3.

showed, however, that upon taking off the heating current the heat was so rapidly conducted away by the surrounding metal masses as to cause the heated spot to become chilled just as effectually as if it had been plunged into cold water. No method of outside protection of the heated spot would prevent this, and the *gradual* cooling of the spot had to be attained by different means: namely, a gradual and slow withdrawing of the heating current. The method of introducing the annealing current is best shown in Fig. 2.

c c are two copper contacts cooled by water circulating inside. The current enters the plate by one end, and leaves it by the other. Right under the contact, the metal comes to a bright cherry heat, (shown in black) while the portion intervening and partly surrounding the contacts acquires a temperature of just a visible red. Line H H indicates where the influence of the Harvey treatment stops.

The shaded portion in Fig. 2 and 3 shows the zone softened and ready to be machined, while the dotted line shows how far the heat radiation would cause the metal to turn blue. When cooled, the annealed portion shows a chocolate color, while the place where the contacts have been resting, is scaled and hard, and cannot be touched by a tool to a depth of about  $\frac{1}{4}$ ". These places can again be annealed later on, if required.

The apparatus necessary to carry out this process consists of the generator, the annealer proper (transformer) and the regulating apparatus.

The generator is commonly a separately excited alternator of variable potential, of a maximum of 300 volts and 100 amperes. The frequency, preferably, should be low, 50 cycles per second being used. When more than one annealer is to be run simultaneously from one generator, constant E. M. F. of the latter should be used, and each annealer regulated separately by a reactive coil. The annealer proper is a transformer similar to the well-known welding transformers. As the apparatus is to be operated outdoors, on board of vessels during construction, it is important that the same may be handled with immunity from electric shocks, even when operated in mist and rain.

To meet these conditions a copper-clad type of transformer is used, one in which the secondary is composed of two copper castings each having a rectangular groove, which two halves, when bolted together, form a closed rectangular frame in which the primary is held enclosed. The hollow space intervening between primary and secondary is moreover filled with a heavy oil, which acts both as the insulator and conductor of heat from primary to secondary. The secondary, by completely surrounding the primary, affords an excellent mechanical protection, and prevents electric as well as magnetic leakage. The primary is a copper ribbon insulated with asbestos, and the ratio of conversion is 100 to 1. The transformer has two trunnions fastened to its sides, in a line a little above the center of gravity, which trunnions swing in bearings, part of a yoke which straddles the whole. The yoke in its turn has a hook which may be secured to the latter at any place of the arch, thus allowing the transformer to be suspended, like a compass in gimbals, in any position desired.

It goes without saying that the copper castings which compose the secondary are cut through at one place in the circuit. On either side of the cut, two short platforms form the base for copper



contacts of various shapes and sizes, by means of which the currents are made to enter and leave the plate to be annealed. These copper contacts are of forged copper, hollowed out to receive water circulation for cooling purposes, and terminate in narrow tips rounded at the end.

The weight of the whole annealer, being approximately 1000 pounds, is sufficient to give proper contact pressure for all work on a horizontal plate. When inclined surfaces, vertical or otherwise, are to be worked upon, the transformer is suspended so that

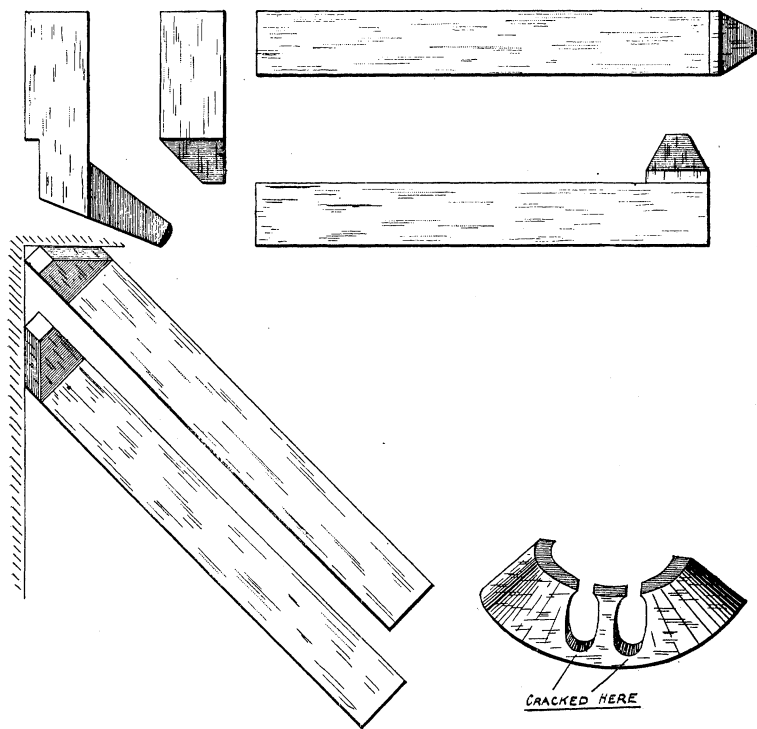


FIG. 4.

FIG. 9.

its weight shall not interfere with the contact pressure, which is obtained for work by bracing the contacts directly with wooden wedges against any object near by. On the outside of a hull, it is proposed to use a pair of electro-magnets, which are made to hold themselves against the iron hull, and form a support for the annealer. Fig. 4 shows some of the various shapes of contacts that are used in various positions.

The remarkable thing is the great amount of current that is

being carried by the copper contacts into the plate. The contact surface is seldom more than about  $\frac{1}{2}$ " square, and yet 10,000 amperes are made to flow through it continually. This is equivalent to 40,000 amperes per square inch, a density which is only possible on account of the thorough cooling by the water circulation.

The regulating apparatus is in most cases simply a rheostat in series with the field of the generator. When more annealers than one are run simultaneously from one generator, as mentioned before, a reactive coil is interposed between the two, and this latter has been made automatic; that is to say, provided with a dash-pot, which permits the current to be reduced uniformly and at any given rate it is set for.

This reactive coil, Fig. 5., is composed of a solenoid coil of cable, well insulated, having a movable laminated iron core which is raised out of the coil by means of a leather strap and winch. The core is composed of thin iron strips placed side by side around a circle, and projecting radially from the same, and being held on top and bottom by a slate disk, in a manner similar to the securing of the copper segments of a commutator. No insulation of the core is necessary, and good ventilation is obtained. The core once raised out of the coil tends to return by gravity and the attraction of the solenoid, but is checked in its descent by a pair of dash-pots, one on each side of coil. These latter communicate with each other, top and bottom, and have one of the pistons provided with a valve which opens when the core is raised, and closes when the core descends. The dash-pot cylinders are filled with a light mineral oil, which does not freeze nor clog under any ordinary conditions of temperature. An adjustable by-pass valve allows the oil to flow from the tube to the top side opposite. By opening or closing this valve more or less, any rate of descent and, consequently, diminution of current, can be uniformly obtained, without requiring any skill on the part of the operator.

The annealing operation is carried out as follows: The transformer is placed in position, the contacts touching the plate either side of the place marked to be annealed, and the primary current brought up by means of a rheostat to from 75 amperes to 90 amperes for about two minutes, according to the size of spot to be annealed, which will bring the metal to a dull red heat, a temperature at which a pine stick catches fire when held in

contact with the plate. If no reactive coil is used, the current is now diminished by turning the rheostat one point every minute. If the reactive coil is used, the core is now raised by winch, the coil put in circuit by opening a short-circuiting switch, and then

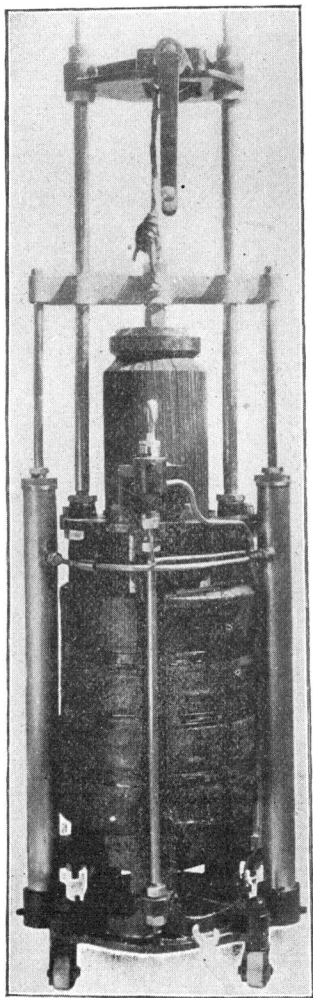


FIG. 5.

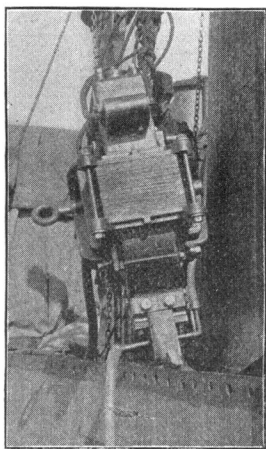


FIG. 6.

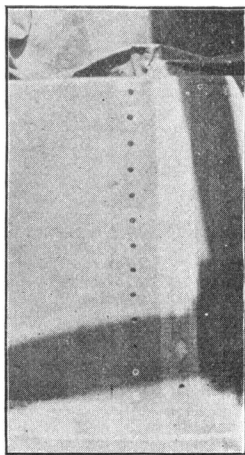


FIG. 7.

is allowed to descend on its own account. The operation generally takes *seven minutes*, all told. Accompanying Figs. 6, 7 and 8 show the proper apparatus in operation on the "Massachusetts" and "Oregon." No difficulty has been experienced

from the beginning. The annealing of individual spots was, however, only the stepping-stone to a more important work of a similar nature, work which was about to be given up, owing to what were considered insurmountable difficulties.

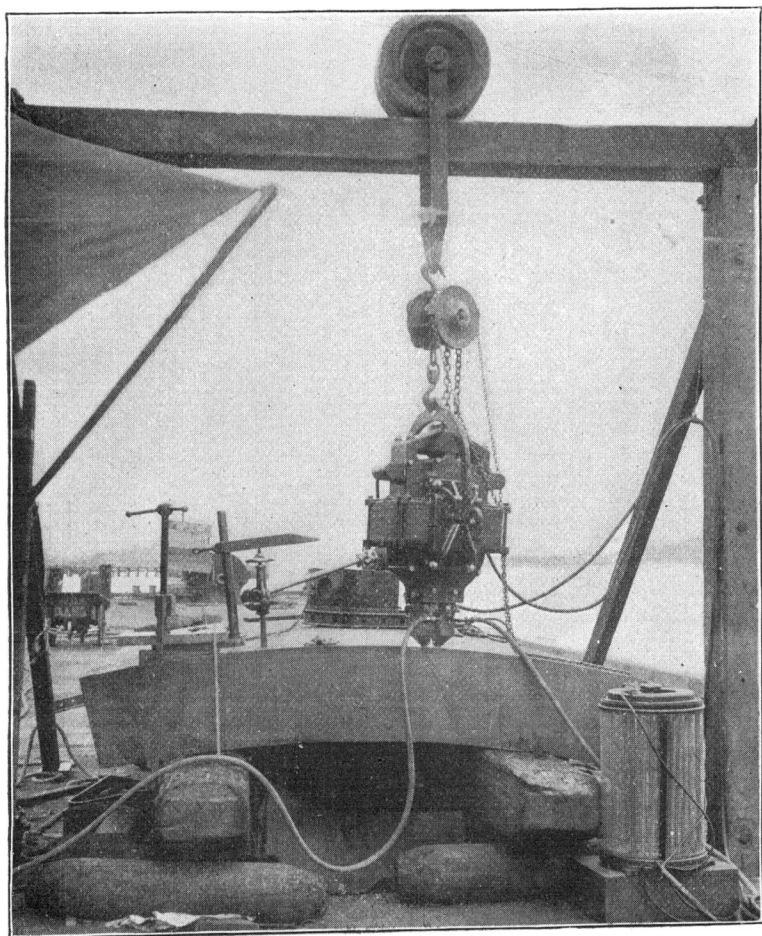


FIG. 8.

In the construction of a modern man-of-war, there are many armor plates which act as shields to the guns, and have to be perforated to allow the gun muzzle to pass through and to be either raised or lowered. Some of these shields are circular or

oval, with narrow edges around the ports, in the case of Harvey'd plate. To perforate these shields after carburization, and before being water-hardened, was the only possible way, since previous experiments had shown that prevention of carburization could not be relied on, and no process was known to anneal the plate locally after hardening. The hardening of a plate once perforated, showed itself to be, however, almost impossible; in fact, a matter of chance. In most cases the plate cracked in two as shown in Fig. 9, or the whole plate became distorted in such a way that it could not be used. As individual spots

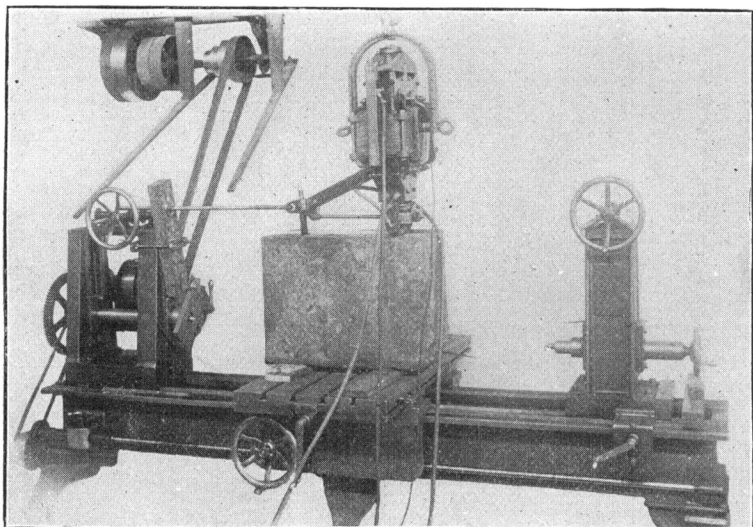


FIG. 10.

for holes could be annealed, there could be no doubt that a series of annealed spots could be likewise obtained by the electric process, following a line along which a cutting tool was expected to be run. The first attempt, therefore, and made in England, was to anneal a number of spots in proximity to each other in such a way that the annealed zones should overlap each other.

As described above, it is very important that the temperature of any individual part should be gradually and slowly withdrawn; and while for individual spots the only possible way to do this was by gradually diminishing the current, it was obvious that when a line was to be annealed, instead of annealing a number of spots side by side, the same effect of withdrawing the heat

gradually from one portion could be obtained by moving the apparatus itself relatively to the plate to be treated. The rate of this movement, of course, depended upon the rate at which the temperature should be allowed to fall in any particular spot to prevent chilling. The apparatus was therefore arranged to be moved along a line to be annealed, the motion being obtained by an ordinary screw and nut held in a bracket, the nut being turned at a predetermined rate controlled by a watch. It was found that a speed of about  $\frac{1}{4}$ " per minute was sufficiently slow to ensure thorough annealing.

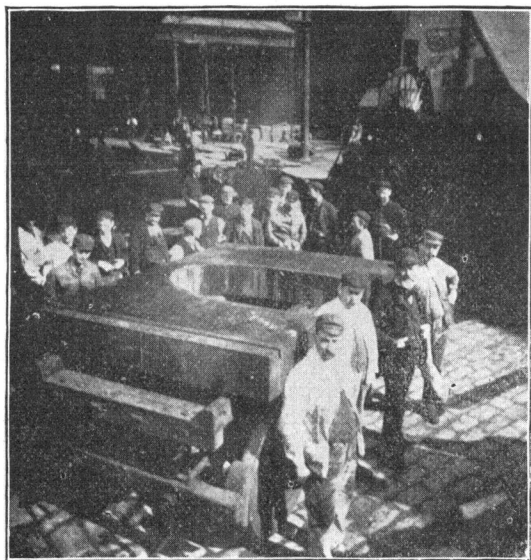


FIG. 11.

The copper contacts were of the simplest kind, as described above, bedding themselves partially in the surface, and when being dragged along by the screw and nut, raised in front of themselves a burr or chip similar to a planing tool. After a whole day's continuous use the copper contacts were found intact, while a number of chips from the steel surface were lying about. We thus had the peculiar phenomenon of a hard steel chip cut with a copper tool.

Upon the completion of the work, it was found that a strip about  $2\frac{1}{4}$ " wide throughout the length over which the machine

had been moved, could be operated upon by drills or a shaper, in a manner as easily as if it had never been hardened before.

In the work just described, the apparatus was moved about, but in regular practice it would be better to construct a machine consisting of a large bed, on which the plate to be treated may be fastened and moved in any direction automatically at a predetermined speed, while the annealer proper is suspended in a given position above the plate, as shown in Fig. 10. The annealing operation occupies but a small percentage of the time required for the cutting.

Fig. 11 gives a view of a sample plate annealed by the method described above, and cut out to represent a port-hole as is used on the turrets of a man-of-war.

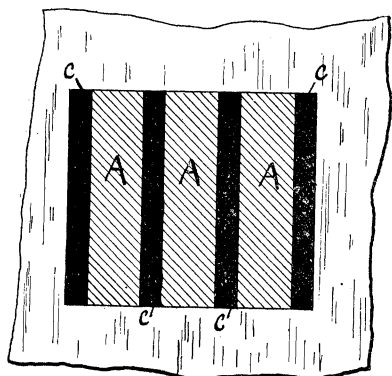


FIG. 12.

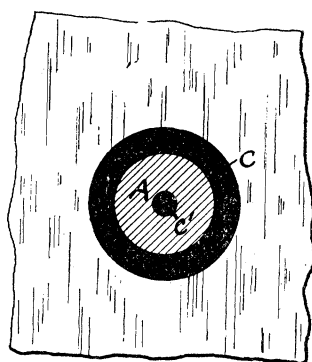


FIG. 13.

It is unnecessary to state that when the apparatus is used for continuous annealing, the primary current is kept at a nearly constant value, the diminishing of heat at any individual spot being obtained solely by the moving of the apparatus from it.

As mentioned before, the places where the contacts are passing over the plate, being brought to a higher temperature than any other, remain hard. Experience has demonstrated, however, that they may be re-annealed later on, by treating the spots in the same way as any other hard spot on the plate. By this means we are therefore able to anneal any shaped portions, not merely lines. This is best seen in Fig. 12, in which a series of strips are annealed side by side (shown in shaded lines A.) The hard faced surface is then removed on such places by a planer and drill; the machine is then run a second time over the annealed strips, rest-

ing it this time on the bottom of the groove and on the softer metal, thus annealing the ridges *c* left between the annealed strips, on which ridges the contacts were running previously. When all these strips are annealed they may be removed by machine tools without any further difficulty. In a similar manner a large round plate may be annealed, as shown by Fig. 13. The transformer is set on the plate, one contact resting on *c'*, the other at any other place in circle *c*; the apparatus is then slowly revolved around contact *c'* as a center, until the second contact has completed the circle *c*. The shaded portion *A* represents now the annealed surface, which is removed by a cutting tool. The contacts are then made to rest on either side of the center *c'*, and the latter is annealed and removed in its turn.

The apparatus may also be used for the reversal of the annealing process; that is to say for creating isolated hard spots in soft tool steel by sending a current through the spot to be hardened until it reaches a bright cherry heat, and then suddenly removing the current or machine.

Various other applications will suggest themselves in the operation of this process, already adopted by the United States Government. It may be used in the construction of burglar-proof safes, for dies and punches, for projectiles, and other articles of a similar nature.

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#### DISCUSSION.

THE CHAIRMAN:—This paper embodies one of those novel applications of electrical energy in which it is perhaps our function to interest ourselves even more than in the established uses. It is these very new applications which deserve special recognition.

The point which strikes me is that Mr. Lemp is enabled to pass 40,000 amperes per square inch through a contact, of course cooled by means of water; but the mere fact that it is possible to pass such an enormous current density through a contact is certainly interesting, and I should imagine might be very useful in certain cases.

It is also interesting to observe that a current is produced in the secondary of the transformer, and that this illustrates the flexibility of electrical applications—that a secondary which consists merely of a ring of metal with an opening in it, so to speak, is employed to produce the necessary current.

This interesting subject is open to discussion.

MR. EDWARD P. THOMPSON:—While I was listening to the paper, I wondered whether it would refer to the applicability