THE
CANADIAN MAGAZINE
OF
SCIENCE AND THE INDUSTRIAL ARTS.

Patent Office Record.

Vol. XIX. SEPTEMBER, 1891. No. 9.

THE SANITARY REGISTRATION OF DWELLINGS*

The purpose of this paper is to enforce the view that all dwellings hereafter to be built and certain classes of dwellings already erected should be provided—first, with a system of house drainage so arranged and constructed as to guard the inmates from the noxious influence of so-called sanitary appliances; secondly, with a protected indoor water supply as distinguished from a wholesome supply at the fountain head; and lastly, that the dwellings referred to, when so provided and on production of a sanitary certificate granted by competent authority, should be entered in some competent register.

It cannot be denied that the existing legislative provisions as to house drainage and water-supply protection are insufficient to maintain the degree of safety necessary for preserving health, and although other matters appertaining to house sanitation deserve consideration, the two subjects mentioned demand urgent attention, and ought to be dealt with more effectively by competent authority. While adequate ventilation of a house, inodorous surroundings and other matters are of considerable importance, many of them are largely dealt with by existing law. Further, there is this marked difference between some of these useful requirements and those specially pressed by this paper. Bad ventilation and ill-placed dustbins are obvious defects, the purchaser or hirer of a house cannot say that he is misled or deceived, and the maxim *caveat emptor* applies. But with regard to faulty arrangements in the domestic closets and waste pipes and defective and ill-contrived water-cisterns the case is different. The offending point may be discoverable only by the observing powers of an expert or may be concealed from every one until revealed by illness or the breaking up of a building. The mischief is insidious, and as the emanations from sewer connections are of serious consequence to inmates of dwellings it seems only reasonable to draw a distinction between the open and obvious defect and the insidious approach of a concealed danger, and to urge that to meet this danger Government action may be properly invoked.

*A paper by Mr. Henry Rutherfurd, barrister-at-law delegate from the Sanitary Assurance Association, read at the International Congress of Hygiene and Demography.

It is no doubt true that existing law provides that water-closets or equivalent arrangements shall be supplied and that drainage shall be attended to, and it is also the case that under certain circumstances and after certain formalities, entrance of officials into occupied dwellings is authorised to ascertain that the necessary sanitary conveniences have been provided. But it does not appear that a faulty construction of such appliances can be dealt with unless the fault is glaring and the evil therefrom amounts almost to a nuisance to outsiders. In order, therefore, to enabling intending occupiers of new dwellings to be saved from injury it is essential not only that these should be provided with the usual appliances, but that they should be inspected and pronounced good in themselves and suitably adapted to those dwellings. For otherwise the mere requirement that domestic conveniences shall be provided almost amounts in many cases to a statutory obligation to undergo illness or suffer death.

In regard to the water supply, the point now urged is that water for drinking should be protected after its introduction to the house, for obviously, however good it may be at the fountain head, this is of little advantage if it become affected by pollution within the walls of the dwelling. Protection from this should be insisted upon both as regards possible contamination by emanations from discharge pipes and also as regards the position of the drinking-water cistern, so that it shall not be a receptacle for dust or inaccessible for purposes of investigation or periodical cleaning.

With regard to existing dwellings, however, the difficulty of rigorously enforcing such requirements is very great. To insist upon all such buildings being brought at once (even if it were practically possible) to the ideal standard of sanitation would, by reason of the heavy cost and the occasional disarrangement of the buildings, prove an unreasonable demand upon the resources of individuals. But it is conceived first that, without in such cases quite approaching the ideal standard, a minimum standard might be adopted which would still be of considerable sanitary value. Next that the lower standard might be enforced after the completion of a long tenancy or period of years.

As to water, however, whatever minimum of house sanitation experts might consider sufficient, I trust it would not be deemed too severe a demand if, as to protection of drinking water there should be but one standard.

In regard to the use of the word "dwelling," the term is here intended to apply both to residential houses and to all buildings wherein human beings are employed or engaged for any number of consecutive hours. It is not forgotten that the present law, by the Factory and Workshop Acts, the Common Lodging Houses Acts, and others, deals with numerous special cases, and that already some overlapping occurs. But for the purpose of this paper there is much ground that those Acts do not cover, and when such statutes are in effective operation it is not proposed that they should be interfered with by further legislation. It has been stated that with existing dwellings a different standard of sanitation might be accepted and time given for its adoption. With regard, however, to certain classes of such dwellings, I would urge that legislation should at once intervene. I refer to the cases of hotels and lodgings and to Board Schools and other institutions under local control.

The reason for demanding the sanitation of such existing buildings is, that with hotels the public have not always the opportunity of choice. Arriving from the country or from abroad, the stranger in a town must go to such quarters as are available, and the very purpose of hotels is to provide accommodation for travellers who of necessity can know nothing of the arrangements of a dwelling within whose walls they may, under the greatest urgency, be bound for a time to reside. And when we know that, prehaps at home, and certainly abroad, the traveller's life has been cut short by insanitary conditions of hotels, it does not seem much more unreasonable to demand protection from such evils than to insist that for some hours daily there shall be no sale of alcohol.

Lodgings, though not quite in the position of hotels, are included therewith because where the business is a regular occupation the functions of the lodging-house are very similar and the position of the guest almost equally defenceless.

Board schools are placed in the same category, because attendance of the children is compulsory, and they neither know nor care about sanitary arrangements. As to the parents they are probably altogether excluded from an opportunity of inspecting those departments, and it is quite possible that even if it were granted and the condition of affairs were grossly unsatisfactory the parents would come to the conclusion that, in comparison with their own, the arrangements were salubrious and even attractive.

It may be urged that the compulsory action suggested is, in the case of public institutions, unnecessary and vexatious. Without saying that my experience of such cases is extensive, I can state that instances of a very gross character have occurred. Where, in very large buildings under the control of a School Board, the sanitary arrangements had been pronounced faulty and dangerous to health, and several deaths have ensued therefrom, the Board nevertheless failed to take such action as was necessary, and the schools were after the holidays reopened on the alleged ground that there had not been time or it was not then convenient to carry out the operations so imperatively required.

To an audience of this character it would be vain to attempt by reciting sensational cases to enlist their sympathies convincing their reason, but certainly it would not be difficult to illustrate the point at issue by other examples of grievous suffering and distress inflicted upon the young, the weak and the helpless.

We have now to inquire as to the sanitary registration of the buildings referred to. It is conceived that the best mode of enforcing the observance of sanitary regulations is to establish a public register in which to enter a reference to every building which has complied with such regulations, and to provide that no buildings should be inhabited until so registered. The registration would be effected on production of a certificate of due sanitation from some competent authority. Then inasmuch as the sanitary condition of a house may vary with lapse of time, it is proposed that quinquennially an inspection should be made, and the fact, if all be found in order, endorsed on the certificate. But if any discovered evil should within a certain period not be remedied, the house would then at once disappear from the register. In the case of change of tenancy during the quinquennial period, or structural alterations endangering the sanitary arrangements, it should be obligatory on the house owner to obtain inspection and notify results to the sanitary registrar.

In this connection it would be well to consider whether encouragement should not be given to the voluntary sanitation of dwellings, for the time being excluded from compulsory regulations, by entering them in the register when duly certified, on such easy terms as to fees and otherwise as might be thought expedient. It is probable that many house proprietors would be willing and eager to conform to such modified regulations with the view of attracting tenants, or securing more remunerative rents, the result in either case being to the benefit of society at large.

The question still remaining is that of the persons or parties competent to issue the sanitary certificates. Whilst admitting to the full that the educated official persons at present in charge of the public health are competent and desirable authorities to grant such certificates, it is considered that the power in question ought not to be confined to the officials of the State. Sanitary science is still young, and it may be that progress would be more surely made by extending the power to certify to such medical men, architects, engineers or associations as have themselves, or through their staff, recognised diplomas of sanitary knowledge. Just as under the Vaccination Acts, while the act of vaccination is often performed by official persons, the statute may be complied with through means of other persons, provided they are qualified by diplomas of recognised validity.

It is not denied that some difficulty may arise on this part of the subject, and the limits allowed will not permit of its being fully dealt with. But it may be suggested that the reckless or fraudulent issue of certificates could be met by severe penalties, while the offenders would still be left open to the public trial of a civil action for damages at the suit of any injured party.

Lastly, although the measures recommended in this paper may not be "heroic," it is submitted that they are worthy of consideration, and that their adoption would to no inconsiderable degree work for the general good. In asking for State interference, it must be remembered that we are making fresh invasion on private liberty, and we ought not to extend this invasion further than is absolutely necessary. Also, the theoretical sanitarian is bound to consider what are the prospects of passing ideal schemes into effective law. The insistence of a very high standard may lead to immediate failure and possibly to a disastrous postponement. On the other hand, there can be no doubt that if, by the limited scheme here presented, dwellings should be provided with appliances of the character specified, examined in their respective positions and periodically supervised, a great improvement would be conferred upon the habitations of the people, slow and lingering disease would be diminished, the tone of the general health would be raised, and something will have been done to increase the happiness of many an individual home.

CHAT WITH A CHIEF ENGINEER.

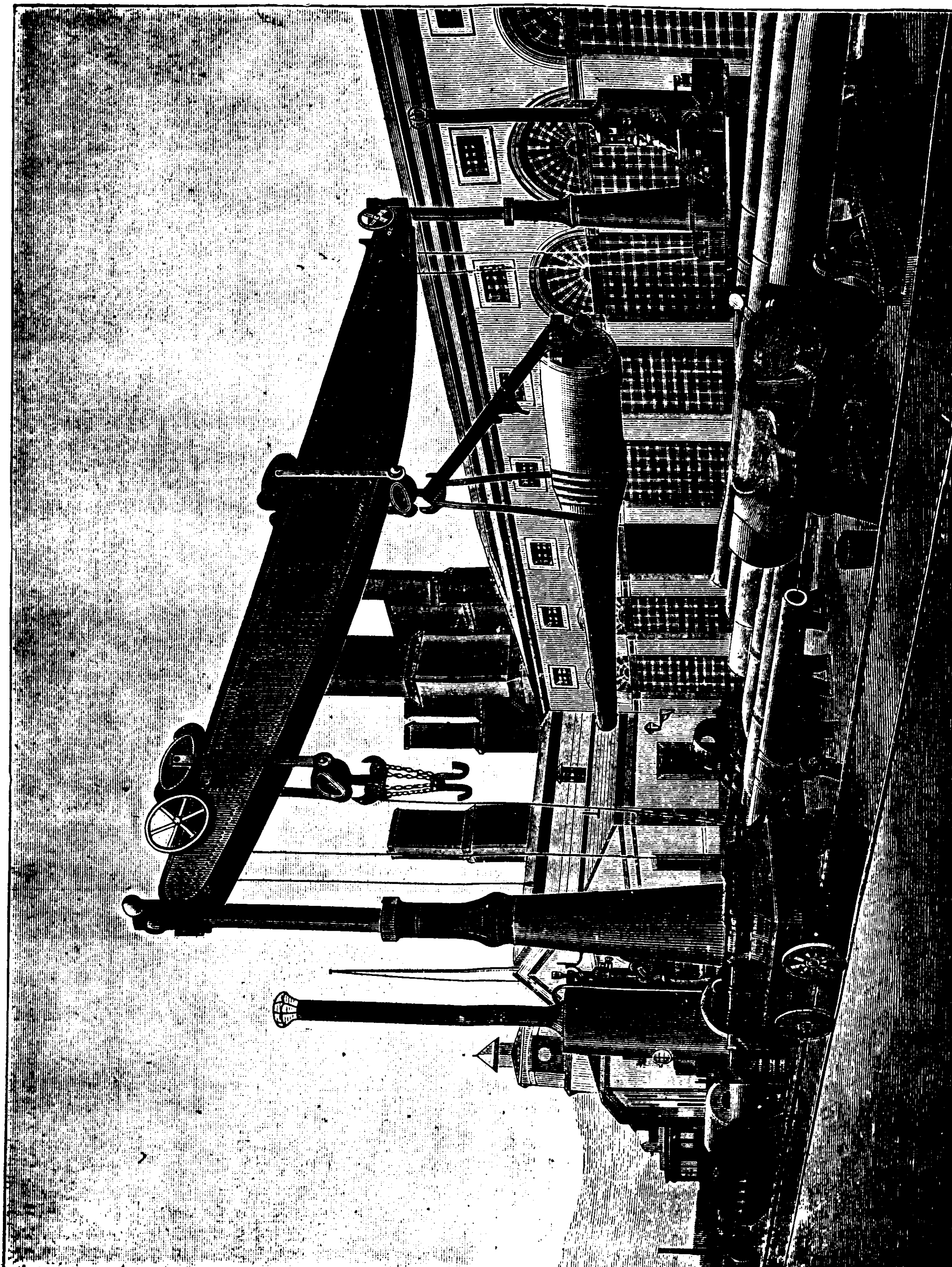
"I see there is another case of boiler blister in one of the new whale-shaped barges," said the chief engineer, "and it would be interesting to know who pays for the blister. The engineer says 'soft steel' in the furnace did it, and the boiler builder says it was the engineer's negligence that did it. What the owner thinks will cause the biggest argument. The first thing to consider is whether or no the boiler builder would put 'soft steel' into a boiler. Sec. 4430 of the steamboat inspection rules would bear down pretty hard on this 'soft steel,' but a decision from the treasury department a number of years ago only requires inspection of shell plates. (In parenthesis I would remark that the United States government pays out at least $100,000 each year for marine boiler inspection, and pays not one cent for stationary boiler inspection, from which one might infer that marine engineers' lives are worth preserving.) But if the 'soft steel' didn't blister the boiler, then the engineer did. I suppose you think the engineer went to work and made a mustard plaster and put it on the tenderest spot? No, it is easier than that. Why, a mustard plaster wouldn't make a boiler stop 'priming,' not to mention warping it out of shape. The chances are that he forgot to play with the surface blower each watch. How would that have prevented the blistering? This way! When the oil or grease came in with the feed water it swam around on the top until it gathered enough sediment to sink it. And by the way do you know that there is calm weather, nor'westers, and regular cyclones in your boiler? Sometimes the water is level and quiet, and steaming like a mill pond on a spring morning, and sometimes again the water at the bottom thinks it isn't having a fair show at steaming, and then the top and bottom water have a stormy time for an hour or two. But this grease gets tired swimming around, and if it isn't skimmed off by the surface blower down it goes on the furnace. Then where that lies heat can not get through to the water, and it stays in the iron until it is red-hot and blisters. If there is any animal grease in the oil the blister comes very quick. You may think this is funny, but take a tin can and after smearing linseed oil on the bottom inside, fill it full of water, put it over a lighted gas jet, and see if the tin don't get red-hot before the water boils.

"This blister on the whale-shaped boat's boilers isn't the only case. Why, one of our bran new steel steamers got a touch of it this spring. The engineer said he filled one of the boilers near the gas-house in Chicago river, and as that was the only one burned, it is reasonable to presume that gassy or greasy water caused it. I have in mind a case that happened several years ago on a boat belonging to a large Cleveland fleet. The engineer ran out of oil and bought some at Duluth. It was learned afterwards that the oil was put in a linseed oil can that contained some of the original linseed. Chemists found traces of the linseed oil on the scale, but the engineer said that it was 'soft steel,' and the owner believed the engineer, which they sometimes fail to do, I am sorry to say. It came near resulting in a law suit. In fact, I don't remember how it did end, but think that the boiler builders convinced the owner. These cases aren't a 'patch on' one or two others I know about. One was on the yacht Peerless. She came from the coast with a surface condenser and the first triple expansion engine that was built in this country. Although the latter was disputed, the former isn't, because as soon as she got away from salt water there was nothing to cut the oil, and as all the condensed water goes back to the boiler, all the oil that got into the cylinders went to the boiler and raised——blisters. The Canadian Pacific steamer Campana had the same experience, but let one of our jet condenser steamers go to salt water, and I guess there would be some blistering—from a different cause, though. The salt left by evaporation would settle down on the crown sheet, and not being used to the salt it would naturally get warm, red-hot, in fact. A young friend of mine went 'first' in the Ranney a number of years ago, and deciding to get rid of the scale, which had accumulated under the regimé of his predecessor, he put a whole barrel full of black oil into the boiler. The result was that the Ranney's furnaces 'came down' in corrugations that would make a Continental furnace jealous. My owner came into the engine room the other day, and among other things he asked was for me to trace the water from the seacock to the condenser discharge, and next time I'll tell you how I did it."—E. N. Gineer, in the *Marine Review*.

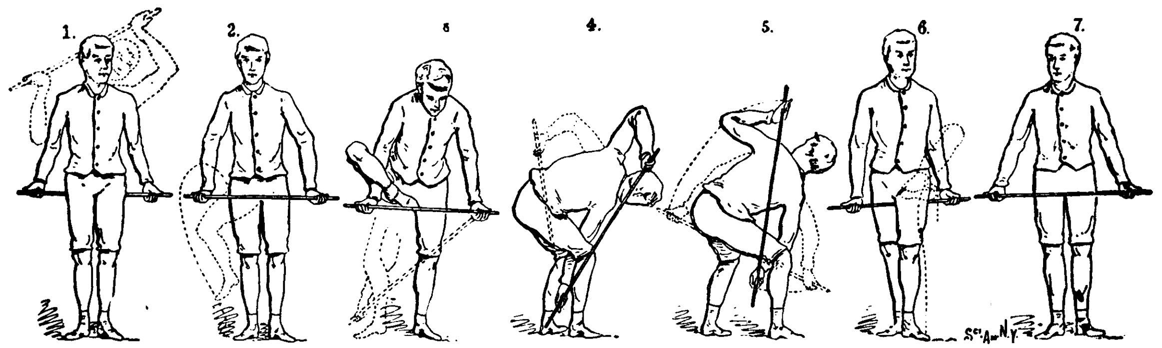
THE GREAT TRAVELLING CRANE AT TRUBIA.

At Trubia the Spanish government has erected extensive works for the manufacture of the heaviest guns and the establishment is now turning out armaments for the new steel cruiser Pelayo and other ships of war. Eleven inch and thirteen inch guns are the largest so far made.

Our engraving shows the new travelling crane lately erected at the Trubia works for handling these great guns and loading them upon the cars prior to removal to the coast. A beam of great strength is supported by its two ends upon a pair of hydraulic posts, each carried on a truck moved by an engine. Each truck forms, in fact, an independent locomotive.



The Great Travelling Crane at Trubia.



GYMNASTIC EXERCISES WITH THE STICK.

Suitable lifting gear and slings are arranged upon the beam, the gearing being worked from the ends of the beams. By means of this apparatus the heaviest guns may be quickly picked up, moved to the desired point, and the load deposited with the utmost precision. Our engraving is from *La Ilustracion Espanola.*

GYMNASTIC EXERCISES WITH THE STICK.

Among the various form of gymnastic exercises, some of the simplest and best are those that are performed with a stiff stick about five feet in length and three-quarters of an inch in diameter. It may be turned out of strong wood, but we consider as preferable a section of a bamboo pole, for it is light, strong and smooth. It may be cut from the smaller part of an ordinary bamboo fishing pole, which, undressed, sells for a quarter of a dollar.

The stick is to be held by the hands in front of the body and the arms then lifted, and the stick thrown over the head to a position in the middle of the back. Inflate the lungs and hold the breath during the exercise. This may be repeated a number of times, and will be found excellent in developing the breast and lungs. With the stick held in the position last described the body may then be rotated, holding the knees firm and the feet with toes turned out. This helps to develop the muscles of the loins.

Then, holding the stick in a vertical position down the back, the body may be swayed back and forth sidewise, and in that way the various muscles of the back, loins and arms developed in a high degree.

We have now to call attention to a more difficult form of exercise with the stick, which is illustrated in the diagrams herewith presented. In the position seen in Fig. 1 the stick is held horizontally behind the body. Care should be taken to place the fingers and thumbs on the stick in the manner shown in the engraving. The next movement, shown in dotted lines, Fig. 1, still holding the hands upon the stick as first described, is to bring the stick over the head in front of the body, into the position shown in Fig. 2. It will be noticed that the elbows in this case, are, by the movement described, bent outward. Take care that the stick is held in the hands as represented in Fig. 2.

The next movement, shown in dotted lines, Fig. 2, is to lift the right leg and place it over the right arm in front between the stick and the body, as indicated in Fig. 3, and to carry down the leg to the floor as indicated in dotted lines, Fig. 3, bringing the stick outside of the leg, which necessitates the stooping posture shown in Fig. 4 ; then carry the stick back along exterior of the body as shown in dotted lines, Fig. 4, to position shown in Fig. 5, thence along the body to middle of back, as shown in dotted lines, Fig. 5, and bring the stick up into horizontal position between the legs, as shown in Fig. 6. The last and final movement is simply to lift the left leg back over the stick, which will then be in front of the body in the position shown in Fig. 7. The exercise may be repeated in reverse order, commencing with Fig. 7 and going back to Fig. 1. This looks like a very simple exercise, but to those who are unaccustomed to its performance it will be found at first difficult to accomplish ; but do not be discouraged. With perseverance, any person, young or old, can finally succeed. Its practice will be found of very great advantage in promoting the strength and suppleness of the muscles, not only of the arms and legs, but of the hands, wrists, knees, shoulders, chest, loins, back, and other parts of the body.

Exercises such as we have described are of the highest benefit to young persons of both sexes, who should make a practice of going through a series of them every day. They require but little time and for home gymnastics are unequalled. They are promotive of good health, beauty, and symmetry of the human figure.—*The Scientific American.*

MANAGING SAFETY VALVES.

An engineer, speaking of neglected safety valves, said : "Safety valves that stick will stick even though tried every day, if they are simply lifted and dropped to the old place on the seat again. If a boiler should be found with an excessively high pressure, it would be one of the worst things to do to start the safety valve from its seat unless extra weight was added, for should the valve once start, it would so suddenly relieve the boiler of such a volume of steam as would cause a rush of water to the opening, and by a blow just the same as in water hammer rupture the boiler. Such a condition is very possible to occur of itself when a safety valve sticks. The valve holds the pressure, that gets higher and higher, until so high that the safety valve does give way and allows so much steam to escape that the sudden changing of conditions sets the water in motion, and an explosion is the result.—*American Engineer.*

THE ECONOMIC VALUE OF HYGIENE.

It is unfortunate in some respects that the Demographic Section of the recent Hygienic Congress should have been thrust into a corner. The Section met at a distance from the others, and was attended by very few English statisticians of eminence, although foreign statisticians were present in considerable force. To this section belongs the function of bringing together the miscellaneous and detached results of the other sections in order to show what is the net result of their varied inquiries. After the constant reiteration of ideas about hygiene—about sewerage, drainage, ventilation, and physical training of the past few years—the question naturally arises whether any practical result has been attained. Is there any return in the extension of life or in increased production for this expenditure of time and energy? Are we stronger or richer, or both, or neither? This focussing of the economic view was strangely enough almost neglected at the Congress. One solitary paper—that of Mr. B. H. Thwaite—dealt with this aspect of the progress of hygiene, yet there was wanting any statistical proof of the effects in general of the sanitary movement of the past half-century upon industrial production. The advantages of life under healthy conditions to producers of any class are too obvious to need insistence. It is clear that a man in the full rush of health, and working under conditions that contribute to health, can do more work and do better work, and be less fatigued thereby, than a man suffering from disease and working under conditions that tend to aggravate or even to produce disease. Yet a definite policy directed to the maintenance of such working conditions as shall contribute to the health of workpeople is not by any means universal among employers. The notion has been prevalent that expenditure in the direction indicated yields no visible return. Some have even regarded the matter as merely sentimental, and where they have exceeded the net requirements of the Factory Acts have taken credit for a philanthropic action. But this is really a false view. It is as bad policy to fail to take adequate measures for the supply of fresh air, and even also of food and clothing, to the men and women who are constantly employed as producers, as it is to stint the supply of coal or of air to the furnace of a steam boiler. The economical use of the man as a producing machine is subject to precisely the same laws as the economical use of the inanimate instrument with which he effects production. A man who works must at least have the opportunities of a machine, and as many more as may be. It would not be difficult to prove from everyday experience, and if need be also from scientific inquiries and statistics, that health and productive power vary directly. The most industrially productive of the working classes are also the most healthy and the most comfortably housed. The conditions react upon each other; but the existence of healthy conditions during labour tends to induce a desire for similar conditions during leisure, and thus to increased health, productive power, and general efficiency of life.

One suggestion of Mr. Thwaite's is open to question. He remarks that during the past fifty years the British workman has degenerated. Without taking a very optimistic view, this may fairly be opposed by a direct negative. Fifty years ago the conditions of labour were much worse than they are now. Fifty years ago the Factory Acts were barely in operation, and the era of sanitary reform had not yet begun. By 1840 the working class had not yet emerged from the depression of the early years of the century, years of such hardship as we have not experienced in these days. Even if a whole century is taken instead of half a century, it is questionable whether the comparison in favour of the former times would hold good. The bulk of the industry of the country was in 1790 still domestic; the conditions under which work was done were, especially in London, very insanitary. The practice of working at home, beneficial in some respects, is not beneficial from the point of view of hygiene. There is really more ground for hopefulness for the future in the reflection that the conditions of labour have become gradually better, and that, although there may be some deteriorating influences at work in our civilization, as regards industrial hygiene, the tendency, on the whole, is towards improvement. It may be well to note that the popular idea, which regards our large towns as places to which men crowd from the agricultural districts and leave outdoor employments to work indoors in the cities, is probably erroneous. Mr. Charles Booth has shown that a proportion so large as to leave only a small fraction of the migrants from outdoor employments in the country resort to outdoor employments in the town. Although the air of the town is less wholesome than that of the country, the difference in the conditions of work for such migrants is not so serious, as it would be were they transferred to indoor employments.

Given a reasonable amount of alertness to their own interests on the part of factory owners and other employers of labour, there is every prospect of the conditions of labour being as greatly improved during the next quarter as they have been in the past quarter of a century. This, moreover, will most probably be accomplished without vexatious factory legislation, or even without any assumed need for it. Another sense in which improvements in sanitation may be regarded from an economic point of view is that of improvements in public sanitation. Mr. Herbert Spencer and others of his school have constantly called in question the policy which resulted in the practical adoption of the sanitary reforms advocated by Mr. Chadwick; but even they would admit at least some gain in public health from the adoption of these reforms. The same result might have been achieved by other than municipal and national measures, but it would only have emerged after a longer lapse of time. Time in such a case means lives, and thus it is undoubtedly fair to say that the sanitary reforms of the past forty or fifty years, although they may have encroached upon the domain of *laissez-faire*, have been accompanied by, if they have not even resulted in, a vast improvement in the health of the community. Since every day's avoidable absence from work involves an irrecoverable loss, both from the individual and from the social point of view, the gain to society from increase of the period of healthy production must have been enormous. Besides this method of quantitatively estimating sanitation, another method consists in the estimation of the amount of municipal capital invested in sanitary improvements of various kinds, such as sewage works, farms, waterworks, and public parks. These form assets to set off against the amount of local indebtedness; but since much of the money expended on these improvements has been raised on terminable annuities, the communities as they pay these off are accumulating a vast amount of municipal capital, an incident which can hardly be left out of account in the economics of sanitation. Whether or not this social capital is being fruitfully or wastefully expended depends upon the sanitary engineers, but that the presumption is in favour of the fruitfulness of much of the expenditure is clear from the progressive diminution in the death-rate in most of the large towns. No doubt other collateral influences have contributed to effect this result, but some of these were at work before the sanitary crusade, while the most manifest period of improvement has been coincident with sanitation.

The subject of the utilization of sewage, which is agitating all the chief municipalities at the moment, met with considerable attention at the hands of the Congress. It is not at all surprising that differences of opinion should exist upon the economic and sanitary advantages of sewage farms. A general conclusion in their favour would be hazardous; but under certain conditions there can be no doubt of their economy. A plea was made at the Congress for the establishment of sewage farms on the score of a national duty, to secure the growth of food stuffs within the nation. The introduction of such a question really obscures the main issue. The multiplication of municipal or national sewage farms, and the pressure of the cost of these upon the rates in unfavourable years, will probably result in a desire for protective measures, and, if this demand should be acceded to, the evil consequences which seem to be inseparable from all protective systems would follow. In the meantime the subject belongs to the regions of sanitary engineering and agriculture rather than to the region of politics.—*Industries.*

A POINT ABOUT STEEL.

The causes from which trouble may come with steel are innumerable.

The rapid multiplication of small, portable forges is doing much to increase a certain kind of trouble with it, and, in fact, this particular cause of trouble with steel has assumed proportions of considerable importance, and by pointing out, as we propose to do, some of the limitations of these small forges, we hope to be able to render a service to steel users and steel makers, and to the makers of the forges as well.

Mechanics understand perfectly well that a hammer must bear some proportion to the size and weight of the piece of steel that is to be forged with it; but it is not so generally understood that this is also true of the fire and forge in which the steel is heated. Of course, we do not mean to say that a different size of forge should be used for every variation in weight of work; but we do mean to call attention to the fact that a furnace suitable for heating for a steam hammer is unfitted for tempering small drills and taps, and that a small portable forge is utterly unfitted for heating a steel die weighing 20 pounds or more.

Such forges have their uses, to which they are well adapted, but when a large piece of steel, such as a drop or trimming die, is to be heated for hardening, the conditions necessary to the success of the operation cannot be secured with such a forge. It is well settled that when such a piece of work is to be heated there must be a good body of clear fire, and that a considerable bed of the fuel must be below the work, between it and the tuyere openings Then the character and distribution of the blast must be such as to keep this body of fuel at a nearly even temperature, and while its volume may be large, it must not be fierce and sharp, but mild and gentle.

Just the opposite of these conditions are present with the small portable forge. No large body of fuel can be heated evenly upon it; the blast coming from a few small tuyere openings, closely grouped together, must be sharp in order to get sufficient heat, and the result is an effect similar to that of a blowpipe, with intense surface and local heating, instead of the evenly distributed low heat absolutely essential to success in hardening such work. Then, too often, when the work cracks to pieces in quenching, the steel maker is blamed.

Of course, there is little of this particular kind of trouble in the large shops, for in them regular forges are always found, and it is to the owners of the small shops, particularly where "rooms with power" are hired for manufacturing purposes, that this is addressed, in the hope that it may show some one a cause of trouble with steel, not previously suspected.

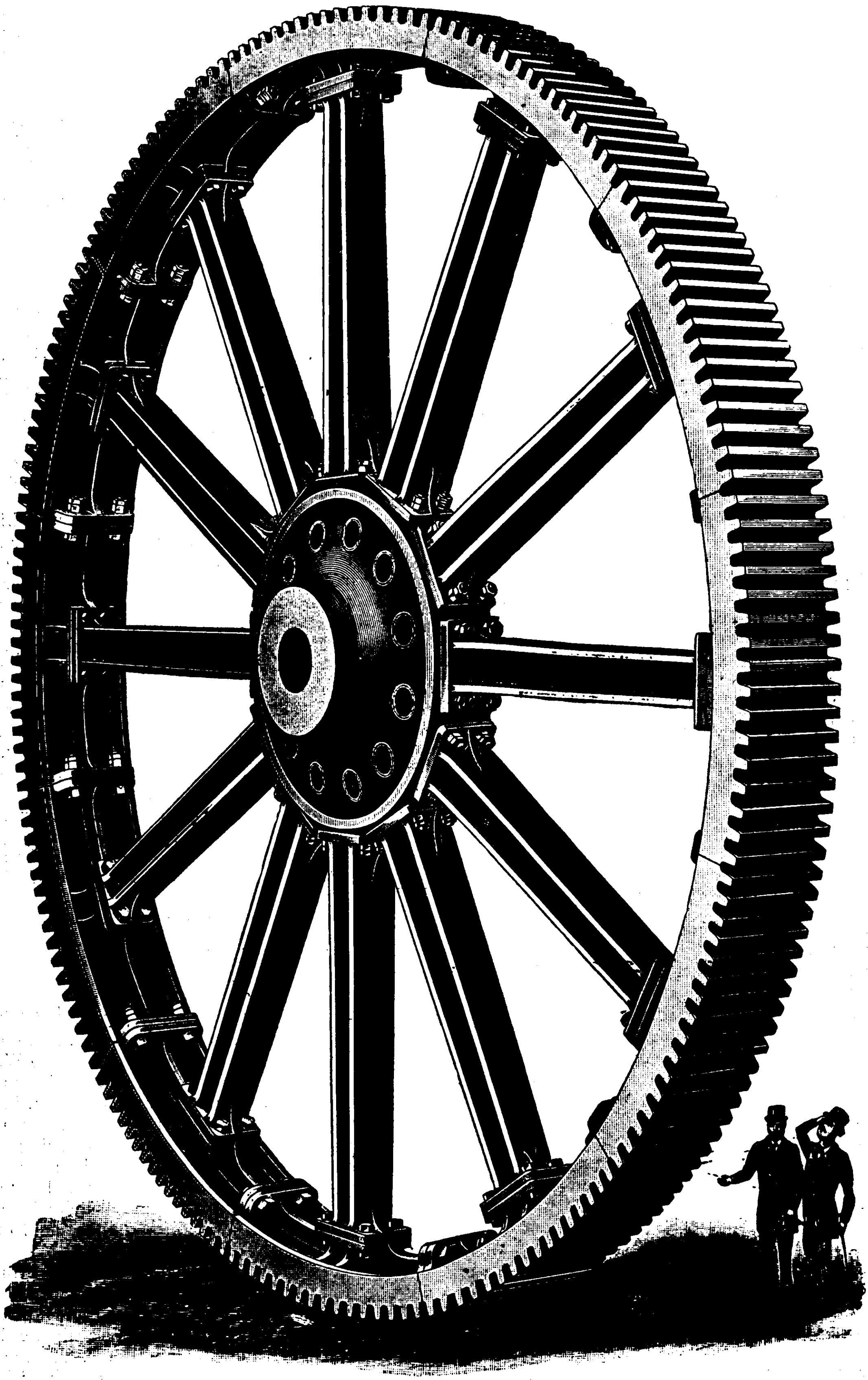
Such small forges as we refer to are excellent for the class of work for which they are intended, and small tools can be hardened with them as well as with any other forge, especially if charcoal is the fuel used; but it should be recognized that they, like most other things, have their limitations. It should be remembered, too, that pure, soft water is a good, if not the best quenching liquid, and that water in which more or less washing of hands with soap has been done is not pure water. The water and the tub containing it should be clean.—*American Machinist.*

MACHINE CUT SPUR GEAR.

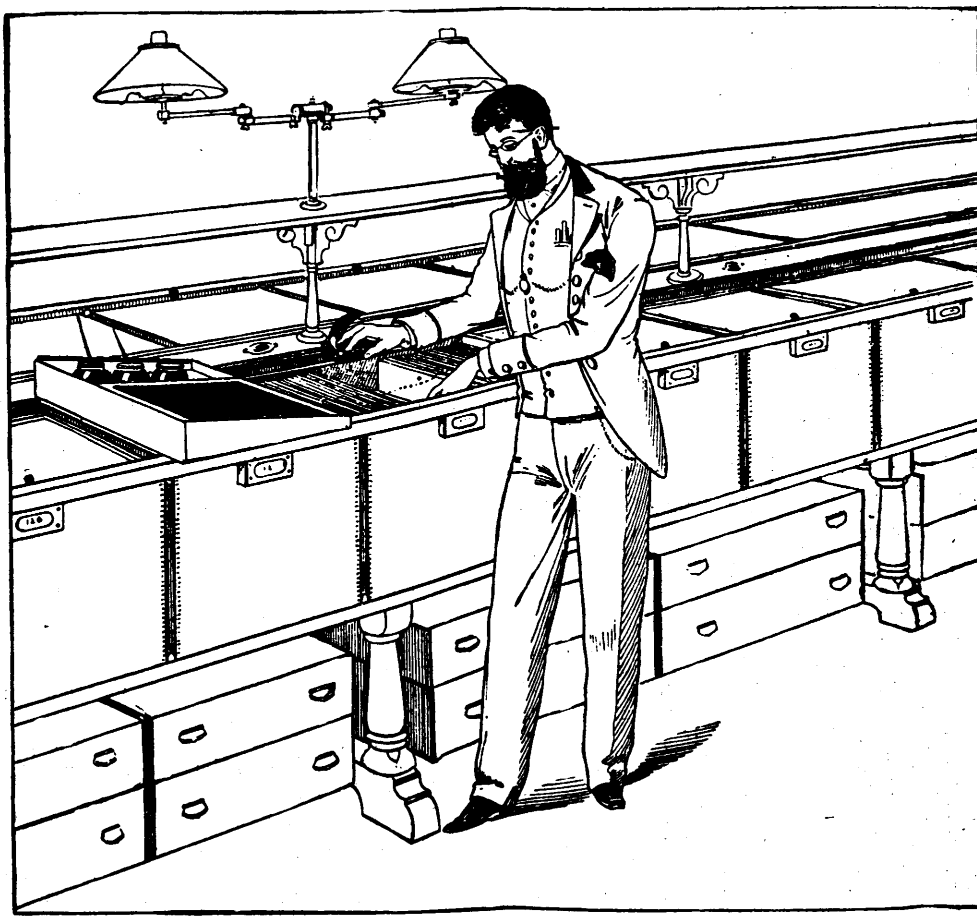
BUILT BY THE WALKER MANUFACTURING CO.

The cut of the gear shown herewith, represents a very large machine cut spur gear, made by the Walker Manufacturing Co., the well-known engineers and machinists of Cleveland, O., which was used, in connection with a steel pinion, made by the same concern, on large pumping engines for removing water from one of the South Africa diamond mines. The dimensions of this gear were as follows: 192 teeth; 30′ 6.66″ pitch dia.; 30″ face; 6″ pitch; bore 27″; diameter of hub 9′ 2″; weight of hub being 15 tons, and the total weight of gear 66¾ tons.

Some conception of the exactness required in the formation of this large wheel may be realized when we say that the owners, in order to provide for a possible breakage, which is most improbable, ordered one segment and one arm additional, the requirements of which were that these parts might fill any position in the wheel.



MACHINE CUT SPUR GEAR.



Mechanical Ledger.

The wheel was fitted up most carefully, and it presents a fine piece of machinery, as may be judged from the illustration.

This gear, with the steel pinion, was the only part of the massive pumping machinery which was made in this country, the balance of work being contracted for in England.

In reply to an inquiry as to why the gears had been singled out for manufacture at a different point than the rest of the machinery, the engineer of the company replied that he thought they could rely on getting a superior class of iron in America, and he knew they could secure as perfect work.

That man knew what he was talking about.—*The American Engineer.*

IMPROVED MECHANICAL LEDGER.

The vast and intricate system of keeping bank accounts involves such a cumbersome, ponderous method as to be a severe tax on both the mental and physical powers, as well as consuming a large portion of time or compelling undue haste. Heavy ledgers, filled with accumulated accounts, perhaps the majority of them closed, must be referred to constantly, the live accounts hunted out at the cost of lifting and turning over pages of dead matter. When the number of live accounts get so reduced as to be almost asphyxiated by the dead accounts in the ledger, it is customary to transfer them to a new ledger, along with a new accumulation. This process is so frequently required as to necessitate the use of a large number of ledgers, besides lifting what would aggregate tons of book matter every month, and valuable time is lost in referring to the accounts. A notable innovation has lately been introduced, the invention of which has been patented by Mr. John A. Langstroth, of San Francisco, Cal. The system is one of such extreme simplicity, directness, and involving so little work, that persons accustomed to the old system may be inclined to question the feasibility of the new method, but the system has been fully tested and highly commended by bankers and will bear the most critical examination. Briefly stated, the system comprehends the use of independent sheets for each account and a series of properly numbered cases, within which said sheets are contained, with certain appliances for holding the sheets in place, protecting them from injury, and for indicating the place of any sheet which may be removed, together with the name of the person who has taken it. In practice, under this system the account cards are placed upright in wooden boxes containing about a thousand each. The box is subdivided into several compartments by thin board partitions, each consecutively numbered to afford a ready guide in finding the division required. When a card is to be removed for posting the account, a spring check block is placed on the desk ledge and a small pivot blade is turned down, engaging between the cards adjacent to the one removed, and accurately marking its place and indicating its absence. The check block has inscribed on it the name of the clerk that places it, each clerk being provided with such a device. The boxes are placed in consecutive order along the desk, and are designed to be removed to the vault at night. As the card accounts become closed or dead, they can be transferred to receptacles provided for the purpose. When a card is taken away from its receptacle it is secured on a clip board, which protects it from injury and distinguishes it from other papers until it is replaced.—*The World's Progress.*

DETECTING FORGERIES ON PAPER.

Recently before the Belgian Academy of Medicine, Prof. G. Bruylants gave an account of the researches which, in co-operation with Prof. Leon Gody, he had instituted with the view of illustrating how frauds and alterations practiced on business papers can be detected. He said:

Although my experiments were not carried on under the most favorable circumstances, their results were satisfactory. A piece of paper was handed to me for the purpose of determining if part of it had been unequally and greatly wet, and if another part of it had been manipulated for the purpose of erasing marks upon it; in other words, whether this part had been rubbed. The sample I had to work upon had already gone through several experiments. I had remarked that the tint of paper exposed to the vapor of iodine differs from that which this same paper assumes when it has been wet first and dried afterward. In addition to this I realized that when sized and calendered paper, first partially wet and then dried, is subjected to the action of the iodine vapor, the parts which had been wet take on a violet tint, while those which had not been moistened became either discolored or brown. The intensity of the coloration naturally varied according to the length of time for which the paper was exposed to the iodine.

There is a very striking difference also when water is sprinkled over the paper, and the drops are left to dry off by themselves in order not to alter the surface of the paper, complete desiccation being produced at a temperature of 212°.

Thorough wetting of the paper will cause the sprinkled parts to turn a heavy violet blue color when exposed to the vapor, while the parts which were untouched by the water will become blue.

If, after sprinkling upon a piece of paper and evaporating the drops thereon, this piece of paper is first thoroughly wet, then dried and subjected to the action of iodine, the traces of the first drops will remain distinguishable whether the paper is dry or wet. In the latter case the traces of the first sprinkling will hardly be distinguishable so long as the moisture is not entirely got rid of, but as soon as complete dryness is effected their outlines, although very faint, will show plainly on the darker ground surrounding the space covered by the first drops.

In this reaction water plays virtually the part of a sympathetic fluid, and tracing the characters with water on sized and calendered paper, the writing will show perfectly plain when the paper is dried and exposed to the action of iodine vapor. The brownish violet shade on a yellowish ground will evolve to a dark blue on a light blue ground after wetting. These characters disappear immediately under the action of sulphurous acid, but will reappear after the first decoloration, provided the paper has not been wet and the decoloration has been effected by the action of sulphurous acid gas.

This process, therefore, affords means for tracing characters which become legible and can be caused to disappear, but at will to reappear again, or which can be used for one time only and be canceled forever afterward.

The usual method of verifying whether paper has been rubbed is to examine it as to its transparency. If the erasure has been so great as to remove a considerable portion of the paper, the erased surface is of greater translucency; but if the erasure has been effected with care, examination close to a light will disclose it, the erased part being duller than the surrounding surface, because of the partial upheaval of the fibers.

If an erasure is effected by means of bread crumbs instead of India rubber, and care is taken to erase in one direction, the change escapes notice, and it is generally impossible to detect it, should the paper thus handled be written upon again.

Iodine vapors, however, show all traces of these manipulations very plainly, giving their location with perfect certainty. The erased surfaces assume a yellow brown or brownish tint. If, after being subjected to the action of the iodine, the paper on which an erasure has been made is wet, it becomes of a blue color, the intensity of which is commensurate with the length of time to which it has been under the action of the iodine, and when the paper is again dried the erased portions are more or less darker than the remainder of the sheet. On the other hand, when the erasure has been so rough as to take off an important part of the material, exposure to iodine, wetting and drying result in less intensity of coloration on the parts erased, because the erasing, in its mechanical action of carrying off parts of the paper removes also parts of the substances—fecula, sizing—which, in combination with iodine, give birth to the blue tint. Consequently the action of the iodine differs according to the extent of the erasure.

When paper is partially erased and wet, as when letters are copied, the same result, although not so striking, follows upon exposing it to the iodine vapor after letting it dry thoroughly.

Iodine affords in certain cases the means of detecting the nature of the substances used for erasing. Bread crumbs or India rubber leave yellow or brownish yellow tints after iodination, and these are distinguished by striæ or more intense coloration, erasure by means of bread crumbs causing the paper to take a violet shade of great uniformity. These peculiarities are due to the upheaval of the fibers, caused by rubbing. In fact, this upheaval creates a larger absorbing surface, and consequently a larger proportion of iodine can cover the rubbed parts than it would if there had been no friction. When paper upon which writing has been traced with a glass rod, the tip of which is perfectly round and smooth, is exposed to iodine vapor, the characters appear brown on yellow ground, which wetting turns to blue. This change also occurs when the paper written upon has been run through a supercalender. If the paper is not wet, these characters can be made to appear or be blotted out by the successive action of sulphurous acid and iodine vapor.

Writing done by means of glass tips will show very little, especially when traced between the lines written in ink. The reaction, however, is of such sensitiveness that where characters have been traced on a piece of paper under others they appear very plainly, although physical examination would fail to reveal their existence, but a somewhat lengthy exposure to iodine vapors will suffice to show them.

If the wrong side of the paper is exposed to the iodine vapor, the characters are visible, but of course in their inverted position.

If the erasure has been so great as to take off a part of the substance of the paper, the reconstruction of the writing, so as to make it legible, may be regarded as impossible; but even in this case subjecting the reverse side of the paper to the influence of the iodine will bring out the reverse outlines of the blotted-out characters so plainly that they can be read, especially if the paper is placed before a mirror. In some instances, when pencil writing has been strong enough, its traces can be reproduced in a letter press by wetting a sheet of sized and calendered paper in the usual way that press copies are taken, placing it on paper saturated with iodine to be reproduced, and putting the two sheets in a letter book under the press, copies being run off as usual in copying letters. The operation, however, must be very rapidly carried out to be successful. As a matter of fact, the certainty of these reactions depends entirely upon the class of paper used. Paper lightly sized or poorly calendered will not show them, while manipulations of which I think description would be rather superfluous here can interfere very materially with the results mentioned above.

Another point consists in knowing how long paper will retain these reactive properties. In my own experiments the fact has been demonstrated that irregular wetting and rubbing three months old can be plainly shown, as after this lapse of time characters traced with glass rod tips could be made conspicuous. I have noticed that immersing the written paper in a water bath for three to six hours will secure better reactions, but although these reactions are very characteristic, they are considerably weaker.—*Scientific American.*

ZINC PROCESSES.

Three different processes, each believed to possess its peculiar advantages, are in vogue among the manufacturers of zinc in Europe. In Belgium, to get pure zinc from the oxide, the latter is mixed with coal and heated in a retort, the zinc volatilizing and coming out of the mouth of the retort as vapor; cadmium is always with the zinc, and cadmium vapor comes out first, and, when lighted, burns with a brown flame, the latter changing to green as soon as the zinc vapor begins to come off; an iron cap is then placed over the mouth of the retort, through which the vapor passes and is condensed into a fine dust, and gradually the cap becomes hot and melts the dust into liquid zinc, which runs into moulds and is cast into blocks. The Silesian process differs from the foregoing only in the retort; the mixture of ore and coal being put in and heated, and the vapor passing out through a tube bent at right angles to the retort; the tube is kept cool, but not cool enough to condense the vapor into solid zinc, as, if this should happen, the pipe would become clogged and the retort would burst. In the English process the retort consists of a tightly covered crucible, through the bottom of which passes a pipe; the pipe is stopped with a wooden plug, and the mixture of ore and coal is put into the crucible and heated, and as the mixture grows hotter, the plug is converted into charcoal, allowing only the zinc vapor to pass through it.—*Exchange.*

AN ENGINEER TAUGHT BY AN INSECT.

It has been said that the operations of the spider suggested the art of spinning and weaving to man. That may be doubtful, but it is quite certain that to a hint from an insect was due the invention of a machine instrumental in accomplishing one of the most stupendous works of modern times—the excavation of the Thames tunnel. Mark Isambard Brunel, the great engineer, was standing one day, about three quarters of a century ago, in a shipyard, watching the movements of an animal known as the Toredo Navales—in English, the naval wood worm—when a brilliant thought suddenly occurred to him. He saw that the creature bored its way into the piece of wood upon which it was operating, by means of a very extraordinary mechanical apparatus. Looking at the animal attentively through a microscope, he found that it was covered in front with a pair of valvular shelves; that with its foot as a purchase, it communicated a rotary motion and a forward impulse to the valve which, acting upon the wood like a gimlet, penetrated its substance; and that as the particles of wood were loosened, they passed through a fissure in the foot and thence through the body of the borer to its mouth, where they were expelled. "Here," said Brunel to himself, "is the sort of thing I want. Can I reproduce it in an artificial form?" He forthwith set to work, and the final result of his labors, after many failures, was the famous boring shield, with which the Thames tunnel was excavated. This story was told by Brunel himself, and there is no reason to doubt its truth. The keen observer can draw useful lessons from the humblest of the works of God.—*New York Ledger.*

THE TRAIN STAFF BLOCK SYSTEM.

Although single track railways are rapidly becoming a thing of the past, there are still many such roads in the country, some of which will be changed to double or quadruple track roads in obedience to the exigencies of traffic, while others will forever remain in their present condition. Some roads are furnished with a double track throughout, with the

FIG. 1.—OPERATOR RECEIVING THE TRAIN STAFF.

exception of a few sections or unimportant branches, which are of necessity continued on a single track system.

In proportion to the traffic, more accidents occur upon single track roads and upon single track sections than upon a double track, and this is to be expected without some very perfect block system, which will prevent the entrance upon a given section of trains from opposite directions, and also limit and control the number and movements of trains passing in either direction. This has been accomplished in various ways by means of electrical devices, mechanically operated semaphores, etc., but a simpler and more effective system is in use upon the Shore Line Division of the New York, New Haven and Hartford Railroad, where the train runs over several miles of single track. The system is as simple as it is effective. It was brought from Europe some time ago by Mr. Charles P. Clark, president of the road, and it has been in successful operation ever since. For our information we are indebted to Mr. Wm. A. Waterbury, superintendent.

At each end of the single track section, in the house of the switchman, is placed a box containing tickets, which are red at one end of the section and white at the opposite end. The box is provided with a lock which can be opened only by a key carried in the end of a staff upon which is mounted a plate bearing the words "Niantic and New London." The key is movably mounted in the staff so that it may be slid out for use, or drawn in for protection. Only one staff is furnished for the section.

The mode of operation is as follows: The engineer of a train approaching the single track section —provided he is not followed by another train— upon entering the red ticket end of the section takes from the switchman the train staff, and retains it until he reaches the end of the section, when he delivers it up to the switchman at the opposite or white ticket end. So long as the staff is retained by the switchman no train can follow the out-going train, as the switchman who gave up the train staff has no means of opening the box, and cannot, therefore, authorize a train to follow the first train, either by giving a ticket to the engineer, or handing him the staff. If, however, other trains are to follow the first one entering the single track section from the same direction, the switchman gives to the engineer of the first train a red train staff ticket from the box in the switch house; at the same time he shows the engineer the train staff, thus indicating his authority to dispatch the train and to send the second train upon its arrival. If but two trains are to pass over the section in the same direction, the switchman gives to the engineer of the second train the train staff, and it is carried to the opposite end of the section and there delivered to the switchman, as in the first case. A red ticket will allow a train to pass in one direc-

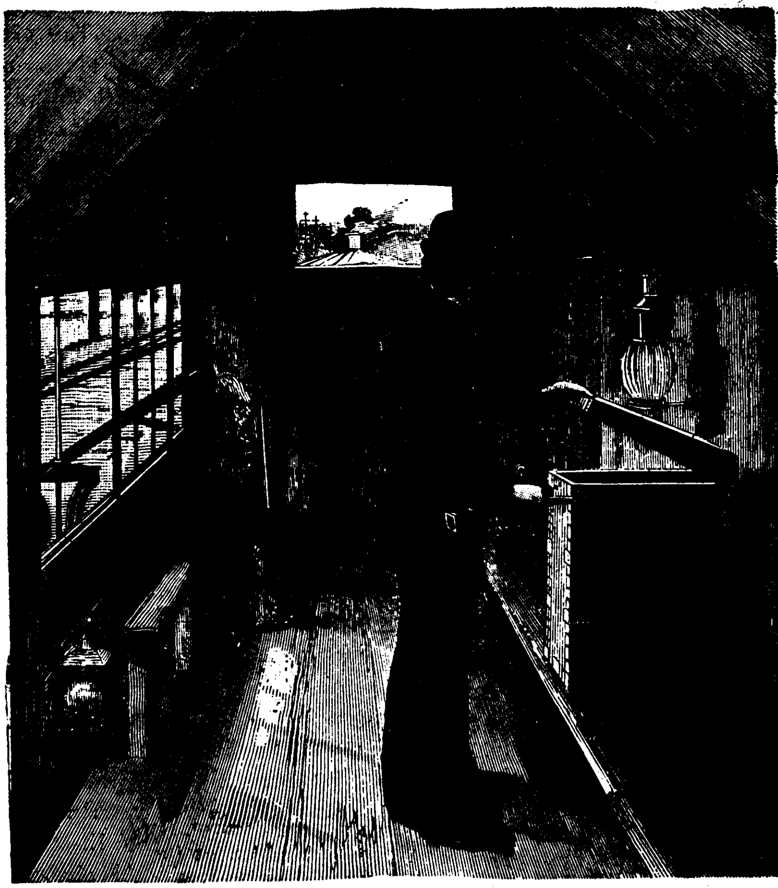


FIG. 2.—SWITCHMAN SECURING A TICKET FOR THE FIRST TRAIN OF A SERIES.

tion only, a white ticket being required to allow a train to pass in the opposite direction.

It will thus be seen that until the train staff reaches the switchman at the white ticket end of the section he cannot admit a train to the section from that end

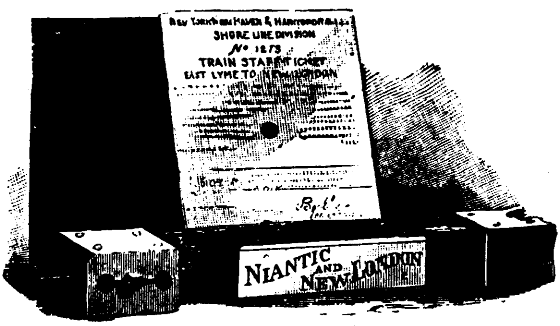


FIG. 3.—THE TRAIN STAFF.

without giving the engineer a white train staff ticket, or the staff itself, a thing which he cannot do until he receives the staff by the hand of the engineer from the red ticket end of the section.

Two trains moving in opposite directions cannot occupy the same section at the same time where this system is rigidly carried out. In this case the engineers and the switchmen are made directly responsible for the safe passage of the trains.

This system has been long in use in Europe on short lines, bridges, etc. It was used on the Tay bridge, and has been quite extensively adopted in Australia.—*Scientific American.*

ACTION OF OILS ON METALS.

A series of tests, lasting some twelve months, on the action of various oils on metals in contact with them, recently carried out, gave the following results: In the case of iron, seal oil acted the least on it and tallow the most. Bronze was not attacked at all by colza oil, and but very slightly by olive oil. It was, on the other hand, vigorously eroded by linseed oil. In the case of lead, the most deleterious lubricant was whale oil; the best, olive oil. Whale, lard, and sperm oils were about equally erosive. Zinc seemed to be but little attacked by mineral lubricant oils. The best oil was lard, and the worst sperm. Copper was not attacked by any of the mineral oils. Sperm oil had the least and tallow the most action on it. Generally speaking, mineral oil attacked the metals under test the least, and sperm oil attacked them the most. In conducting the experiments, the metals were first thoroughly cleaned in ether and then dried. They were next carefully weighed and placed in closed vessels filled with oil, which were kept for a year at a uniform temperature in summer of 80° Fah. and in winter of about 50° Fah.—*Ex.*

"What a success the Electrical Convention has been," is on every one's lips, and truly it was. We feel especially honored in having it held in Montreal, more especially when all the cities of the United States are taken into account, to which, if the Association had turned, they would have been most welcome. They were none the less warmly welcomed here on that account, and we only hope the delegates feel satisfied with the greeting and kind hospitality showed to them. A truly royal Canadian welcome has been tendered to them from this fair city of ours, and we hope and trust that each member has taken away with him a remembrance that will be lasting of the beautiful mountain, fine drives, and attractive buildings which it has been the pleasure of Montrealers to show him. Mr. A. J. Corriveau, and others, deserve a great deal of praise and thanks for their strenuous endeavours in bringing the Convention here, and in helping to make it the success that it was.

We have decided to devote the space allotted to the Electrical Department in this month's issue of our Magazine to a report of the Convention. The various papers read before the Association we have chosen merely to abstract, intending to publish them in full later on. They will be found very serviceable as well as interesting, and they all show careful thought and study. The Association worked hard, and went through a great deal of business. It was found, however, impossible to follow exactly the order as advertised, but one extra session was found all that was necessary to complete the reading of reports and papers. Animated discussions took place after many of the papers, showing what an interest was taken in the meetings. The attendance was fair, and the weather during the entire Convention almost perfect. The Exhibition, comprising so much of interest and value, was a great success. The number of people, who visited it during the evenings, being so great as at times to render the passage ways almost impassable.

THE ELECTRICAL EXHIBITION.

On Monday the 7th of September, at 8 p.m., the Electrical Exhibition at the Victoria Rink was formally opened by Sir Donald A. Smith, owing to the unavoidable absence of Lord Stanley. Until now everything was quiet. The gigantic motors stood motionless. The only source of light was from a few poor gas fixtures with their flickering light. The banks of incandescent lamps were as if dead. Suddenly, at the touch of a child's hand, the wonderful power was let loose, the armatures of the great motors began to revolve, representing many hundreds of horses saddled and bridled, but, unlike the horse, the untiring motors did their work. The hall was soon ablaze with the electric light. The banks and rows of incandescent lamps flashed out, shedding their soft light on the multitudes who walked beneath. From its balcony the band poured forth music to enliven the scene. The effect was beyond description. It seemed almost like some fairy realm, this wonderful working of a force which man has chosen to call electricity, but which baffles his mightiest efforts to explain. It creates a feeling of awe and wonder both at the mystery investing this great force, and at the patient work of those who have succeeded so far in bringing it into practical adaptations to modern life.

Among the most prominent of those who helped to make the Exhibition such a success was the Edison General Electric Company, who occupied about one-half the rink. Their work was chiefly Canadian from their factory at Peterboro, Ont. The Thomson-Houston International Electric Co. occupied one quarter of the rink. Their work was chiefly from their factory in Lynn, Mass. The Ball Electric Light Co., of Toronto, Ont.; the Forte Wayne Electric Co. of Indianapolis, Ind.; the Canadian Electrical Construction, Manufacturing and Supply Co. of Montreal; the Crocker-Wheeler Motor Co., McGill College; Eugene F. Phyllips, (insulated wire,) were also exhibitors.

Among those who had booths on the sides of the rink were the Phœnix Glass Co., of Pittsburg, Pa.; having a nice assortment of globes, shades etc. for incandescent lamps; The Standard Electric Time Co. of New Haven, Conn., showing some interesting work in electric clocks; Wm. Sclater & Co., Montreal, asbestos for various uses; the Delaware Hard Fibre Co., Wilmington, Del.; the Okonite Co., insulated wires and cables; the Germania Electric Co., Boston, who had a very pretty and gay booth, exhibiting the Freeman transformers; the Heisler Electric Light Co., Philadelphia, Pa., who exhibited their long distance system of incandescent lighting; E. S. Greeley & Co., New York, who had a very fine exhibit of electrical measuring and testing apparatus, beautifully finished. The Eureka Tempered Copper Co. exhibited some of their electrically tempered copper. The Consolidated Electrical Manufacturing Co., Boston, Mass., exhibited some beautifully finished switches. A number of the Western standard voltmeters and ammeters were on exhibition also. The New York Insulated Wire Co., showed wires and cables. T. W. Ness, Montreal, a fine assortment of electric bells, annunciators, fans, small motors, telephones, switches etc., making a very creditable exhibit of all kinds of electrical appliances for domestic purposes. The Electrical Engineering & Supply Co., Syracuse, N.Y., had one of the prettiest and most attractive displays in the hall. They exhibited especially the Packard incandescent lamps, the Jenny electric motors and power generators, switches, cut-outs, key-sockets and a number of others. They made a pretty effect by revolving colored incandescent lamps. The Toronto Construction and Electric Supply Co. had a nice display of bells, annunciators, cut-outs, switches, lamps and shades. They also exhibited the famous "Ward" arc lamp for which they are Canadian agents. The Standard Paint Co., New York, exhibited their waterproof paint. Near the entrance to the hall on the left hand side was a remarkable thing, exhibited by the Ries Electric Company, Baltimore, Md., which will probably do much for alternating current incandescent lighting, being a special arrangement in the socket of the lamp by means of which the light could be turned down as gas and left burning, thereby drawing less current. Holland Bros. and Young, Canadian agents for the Edison phonograph, exhibited some of their instruments. Many thousands of people enjoyed the privilege of listening to these remarkable talking machines.

On entering the hall one was struck with the remarkable extent of the Edison exhibit, extending as it did the entire length and comprising so many novel and instructive pieces of apparatus. A complete miniature underground three-wire electric light plant with multiple switch-board was one of the special features. They had an Edison rock diamond drill in operation which worked well. They also had working the largest electric motor in the exhibition. Among other features of their exhibit were a large electric fan, machines for covering wire, dynamos of all sizes, switches, cut-outs, underground main tubes, electric motor car trucks, the famous Edison-Lalande batteries, electrolire fixtures of all kinds and the incandescent lamp manufacture illustrated in all stages. The Thomson-Houston exhibit was a fine one, and occupied the quarter of the rink on the right of the entrance. They illustrated the working of the percussion drill, the electric hoist and electric pump. They had in operation a number of motors for power purposes, a Westinghouse alternating current dynamo, arc dynamo and the famous Thomson meter. Eugene F. Phyllips, Montreal, exhibited a fine assortment of insulated wire. The Forte Wayne Electric Company, had in operation the beautiful "Wood" arc light dynamo recently presented to McGill College. The Western Electric Co., of Chicago, made a pretty display of electric goods. The Russel disc carbon arc lamp was also represented.

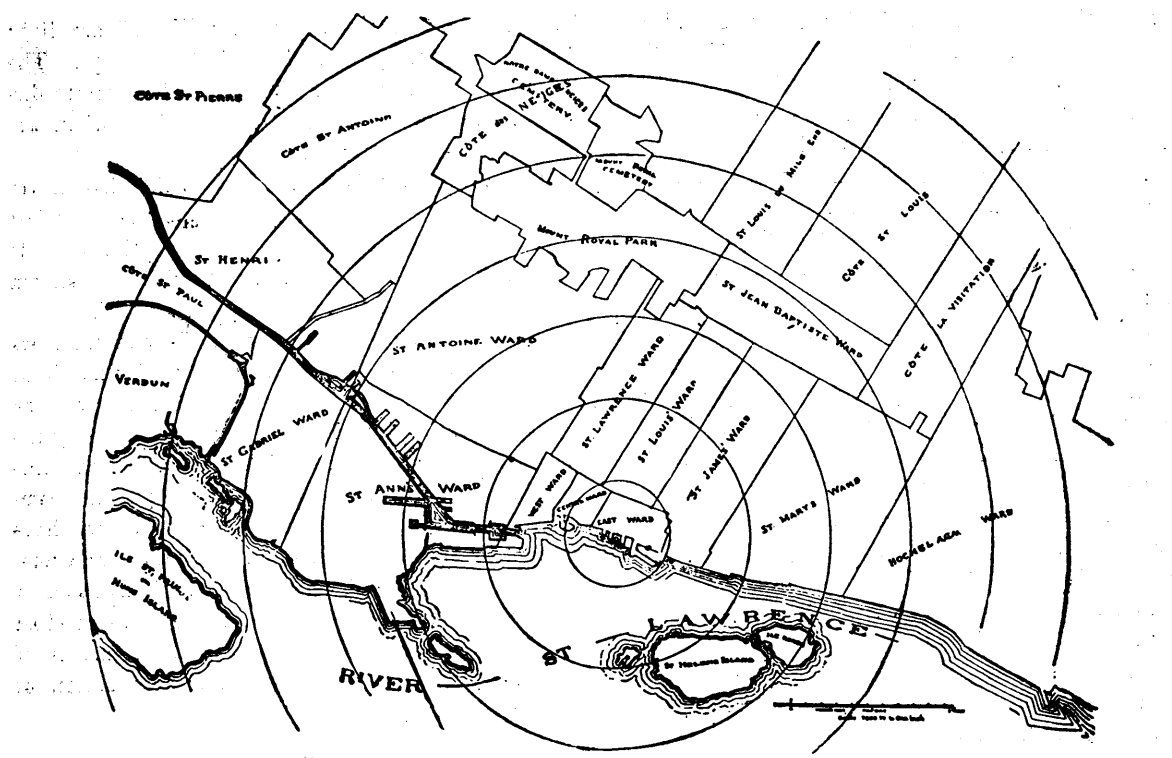
The value of this exhibition, which has never probably been surpassed anywhere, to the electrical interests of Montreal, cannot be over-estimated. It will show the people of Montreal, who have shown in their turn how much they appreciate the honor of having it held here by turning out in vast numbers every night, to what new uses electricity has been put. The electrical industry of Canada will be greatly stimulated, and there is no reason why the many uses to which our neighbours across the line put this wonderful force, should not be put into commercial operation here, much the same as we have profited by the invention of the telephone and telegraph, and the use of which, as Mr. Wyman said in the course of his speech, the Canadians have excelled in. Let new hope, new energy be the stimulus of work in helping to make Canada a great nation of electrical industry.

THE MONTREAL ELECTRICAL CONVENTION.

The fourteenth Convention of the National Electric Light Association of the United States was publicly held in the Windsor Hall, on Monday the 7th of September, where the members and friends of the Convention were cordially received by the citizens of Montreal.

A large number of persons was present, the members being designated by a pretty badge consisting of an oxidized-silver button, having in the centre Ohm's law, $C=\frac{E}{R}$., the symbol of the Society, and around the edge the name of the Association. From this button extended the American flag and British Union Jack on each side of a ribbon with the word Montreal, 1891, stamped in gilt letters. This ribbon was, for an officer, red; for the executive committee, white; for an ordinary member, blue, and for a guest, pearl. The officers consisted of, President, Mr. C. R. Huntley, of Buffalo, N. Y.; first Vice President, Mr. James I. Ayer, St. Louis, Mo.; second Vice President, Mr. M. J. Francisco, Rutland, Vt.; Secretary and Treasurer, Mr. John W. Beane, New York city.

President Huntley opened the meeting by introducing Professor Henry T. Bovey, chairman of the citizens' committee, who in a few well-chosen words extended to the delegates a hearty welcome, and hoped they would obtain both enjoyment and instruction from their stay here. Prof. Bovey then introduced Mayor McShane who also gave a welcome to the Association from the people of Montreal. Then followed speeches of welcome from Sir Donald A. Smith, Sir William Dawson, Ald. Clendinneng, Hon. Justice Wurtele, Ex-Mayor Beaugrand, Ald. Cunningham, and Mr. Richard White. Addresses were then made by the following gentlemen, who in the course



THE "ZONE" SYSTEM OF DISTRIBUTION.

of their remarks extended the hearty thanks of the Association for the kind welcome received; President Huntley, Consul-General Knapp, Hon. Judge Armstrong, and Mr. Erastus Wiman.

President Huntley then delivered an address to the Association. He said that it was the first time in the history of the National Electric Light Association that they have met on other than native soil, yet even in so doing it but adds new evidence to the feeling in the breast of every electrician that his art is foremost among the influences tending to promote human intercourse and break down the walls of separation. He went on to speak of the fact that the day has passed when station managers can limit themselves to one class of service or apparatus. To obtain the best result they must select the machines best adapted to certain lines of work, independent of any particular system. He pointed out the fact that when central stations were desired to be run at their full limit of usefulness, they should adopt the "zone" system of distribution. He illustrated his remarks by a plan of Montreal marked out with various circles, with the central station for the centre. The first circle represented a limit of one-third of a mile, in which limit he held that the ordinary low pressure three-wire system of lighting could be most economically employed. Then followed other zones in which various pressures should be used. He advised the use of large converters in place of the smaller ones now employed, as a large one costs no more to instal than a small one, while the initial cost per light is less in a large one. He strongly recommended the use of the low-tension direct-current system of distribution within its areas. He showed how necessary it is in building a central station, to make ample accommodation for future growth. He also showed how much more economical and serviceable the over-head wiring is when properly constructed than the underground wiring, and ended by urging the Association to adopt yearly meetings instead of half-yearly, as he did not deem it necessary to meet so often.

SECOND SESSION, Tuesday, Sept. 8th, from 10 a.m. to 2 p.m.

The delegates of the National Electric Light Association met in the Windsor Hall on Tuesday, Sept. 8th, to receive the reports of the following committees:—Committee on Relation between Manufacturing Companies and Central Stations, Marsden J. Perry, chairman; Committee on Data, Mr. A. J. DeCamp, chairman; Committee on World's Columbian Exposition, Hon. E. A. Armstrong, chairman; Committee on Underground Conduits and Conductors, M. J. Francisco, chairman; Committee on Safe-wiring, A. J. DeCamp, chairman.

The report on Central stations was an interesting one, showing the position taken by the parent companies and gas companies against the Central station men. It showed that if the Central station men ever wished to save their millions they should have to wage war both on the gas and parent companies. It also showed that while gas was losing its place for lighting purposes it was gaining a place for fuel, and that fuel is a necessity, while light is a luxury. It brought out the facts that the investments of the Central station men now aggregated $100,000,000 and with a union of the stockholders would prove a most formidable opponent to the gas interests.

The report of the Committee on Data was next presented. It contained a schedule of suggestions for the better collecting of statistics and on the cost in different places of electric light. It showed that comparisons should not be drawn between two cities in regard to the cost of the electric light, as in one, perhaps, the generators are run by water power, while in the other they are run by steam. It is absolutely impossible to make the latter system as cheap as the former.

Hon. Judge Armstrong next gave a report for the Committee on Legislation, which aroused quite a discussion among the members in regard to the attempts made to pass various bills in the State Legislatures, detrimental to the interests of the Society, some contending they were done for revenue purposes only. The report on the World's Fair was very interesting. Mr. J. A. Hornsby, secretary of the Electrical Section, spoke of the various plans formed for the electrical work, illustrating his words with a large plan of the grounds. He also spoke of the efforts being made to hold a grand International Electrical Congress in Chicago during the Fair. The report on Underground Conduits and Conductors was found too lengthy, as the time was getting short, so it was decided to have it at the next meeting.

Judge Armstrong next read a portion of the report on Safe Wiring, which showed a very carefully prepared list of rules relating—Class A, to Central stations for light or power, giving some four rules relative to the setting up of generators or motors, eight rules on care and attendance, four on switch-boards, three on resistance boxes, and equalizers, and five on the setting up of lightning-arresters. It also says that series and alternating circuits should be tested every two hours to discover any leak to earth of the current while in operation. Class B—Arc (series) systems. To this class belong the rules for the proper construction of overhead conductors showing how they should be constructed and secured. It gave the following formulæ for the soldering fluid to be used in making connections:—Saturated solution of zinc, 5 parts; Alcohol, 4 parts; Glycerine, 1 part. It emphasized the fact that telegraph, telephone and similar wires, must not be run on the same pole as wires of either high or low potential, which also should not be run on the same pole.

Seven rules were specified for interior conductors in this class, and six for arc lamps, giving a careful description where and how to set up and run arc and incandescent lamps in a series circuit.

Class C comprised the incandescent low-pressure system and gave valuable rules for outside overhead conductors, underground conductors, inside wiring, special wiring, what interior conduits must not be, what double-pole safety cut-outs must be, giving a table of Brown & Sharp's, Birmingham and Edison Standard gauges with carrying capacity of the wire, switches, arc lights on low potential circuits, fixture work, electric gas-lighting, pendents and sockets.

To Class D belong the rules for the alternating systems; as to the placing of converters or transformers and putting up of the primary and secondary conductors.

Class E covered the electric railway giving some general rules for ground return, the size and position of placing trolley-wires, car-wiring, lighting and railway power wires.

Class F comprised batteries; the rules applying to the dynamo-circuit developing the same difference of potential must be followed.

To Class G belong some miscellaneous rules as to the testing of a circuit, the placing of lightning arresters, and the proper protection of telephone, telegraph and other instruments against the increase of current arising from the cross of their line, with any electric light wire, etc. The meeting then adjourned.

THIRD SESSION, Wednesday, Sept. 9th, from 10 a.m. to 2 p.m.

The third Session of the Association abandoned the Windsor Hall and met in the Ladies' Ordinary of the Windsor Hotel. The first order of business was the discussion of M. T. C. Smith's paper, read at the Providence meeting on "The Distribution and Care of Alternating Currents." The general discussion that followed was to the effect that the most economical method was the overhead running of wires, and that the strong objections that had been raised to that form of wiring, were chiefly through careless and inefficient work.

The next paper read was on "Central Stations operated by water power," by Geo. A. Redman, Superintendent of the Brush Electric Light Company of Rochester, N. Y. Mr. Redman's paper treated admirably the system of operating Central Stations by water-power in the city of Rochester. The essayist referred to the gradual diminishing of the water supply owing to the destruction of the forests, and the method adopted for storing up water during the rainy season, for use in the dry. He described the older forms of water-wheels, such as the paddle and flatter wheels which only used the impulsive action of the water, and then the improved forms of Leffel, Victor, Lesner, and Success, which are used to a great extent to-day. There is a demand for good and efficient turbines. They should be constructed so as not to impede the velocity of the water more than one-third, and made of the best phosphorous bronze in order to stand the wear and tear. He recommended the use of horizontal turbines rather than vertical ones, as the former are much easier to take care of and the dynamos can be belted directly to them, while in the vertical a large amount of gearing is necessary. A number of small turbines is better to operate than one large one, on account of the less likelihood of the shutting down of power when a break occurs. He described the former equipment of the Brush Company when operating the lower falls of the Genesee River, which consisted of two buildings on the west side of the river, operating two 30½ inch Leffel, two 20 inch Victor, and one 40 inch Leffel turbine; the first four turbines under 94 feet head, and the latter under 28 feet, producing a total horse-power of 2,500. This station was used for five years and then a new one was built operating 15 double 15 inch horizontal Lesner turbines under 90 feet head, giving a total power of 3,360 horse-power, using 6.95 cubic feet of water per minute per h. p. Only one turbine was damaged in four years. For reserve power they have a 600 h. p. Cooper-Corliss engine. Records are taken of starting and stopping of each turbine, of the speed and load on them, and of any variation in height of water. The power is supplied at a very low figure as street arc lights at 27 cents per night; commercial arc lamps per evening 25 cents; 16 c. p. incandescent lamps $5 to $20 per annum. The Edison Electric

Light Co's plant operated by Leffel mining wheels gives 600 h. p. under a head of 90 feet. They supply incandescent 16 c. p. lamps at one cent per lamp per hour. The paper was a very interesting one.

The next paper read was by Mr. H. Ward Leonard, of New York, and was on "A Central Station Combining the Advantages of both Continuous and Alternating Currents." Mr. Leonard's paper shows great thought and careful study of the method of combining the advantages of continuous and alternating currents. He is a man prejudicial to neither system by recognizing the utility of both. He spoke of the high efficiency, reliability and safety of the three-wire system which is open to the direct current, and with which the alternating current suffers by comparison. On the other hand the first cost of the alternating current system is much less, making it a good system for new territory. He pointed out the want of combining the two systems into one common distribution, and showed the necessary conditions for such. In the daytime a continuous current must be supplied for power purposes, the outlying districts must be supplied with alternating current at night for lighting, one must not operate the alternating system under light load when its efficiency is low, and must be able to supply current throughout the twenty-four hours of the day. He gives a very neat description of a plan for meeting all these requirements. He recommends the use of converters large enough to supply a block of houses. He also pointed out another plan of operating storage batteries during the day when the load was light, and the alternating system during the night under a heavy load, as it is not profitable to use the converter system under a light load. The paper was altogether an interesting one and deserving of much praise. Then followed an animated discussion.

The closing paper was read by Mr. J. J. Burleigh, of the Camden Lighting and Heating Company, on "Uniformity in keeping Central Station Accounts." This paper is one which will be of value to Central Station managers. Mr. Burleigh shows how important it is for Central Stations to have one uniform method of keeping accounts, as the average cost of certain items of expense in one station often exceeds the average cost of the same items of expense in another. He shows that the operating accounts proper embrace the keeping of the original plant in good order. He urges the Convention to adopt some uniform classification of expenses to be recommended to central station men. He also gives some schedules for working accounts which will prove very useful. The discussion showed how necessary it was to have accounts kept systematically, and that no two stations kept their accounts alike. The meeting then adjourned.

FOURTH SESSION, Thursday, September 10th.

The first order of business of the fourth Session was the reading of telegrams from Norfolk, Va., and Augusta, Ga., with reference to the holding of the next Convention. The first paper read was by Capt. Eugene Griffin, on "Three years' development of Electric Railways." Mr. Griffin's paper was an interesting record of the remarkable three years' development of the Electrical Railways. He opened the paper by referring to the first record of an electric car, to be found in the fourth verse of the second chapter of Nahum. But notwithstanding this the electric railway became a commercial success only in 1888. Previous to this time experimental cars only were run, except in the case of the East Cleveland Street Railway Company, which in 1884 ran an electric car on schedule trips over a mile of road. He went on to describe other roads run during exhibitions such as the one run at the Toronto Annual Exhibition in 1884. He spoke of the earnest work of Mr. Sprague in establishing an Electric road at Richmond, Va., in 1888. The practical working of this road induced Mr. Whitney and his brothers, directors of the West End Street Railway Co., of Boston, to adopt electricity in place of the cable system. He showed the marked growth in electric roads by giving the statistics of the number of roads, miles of tracks, etc. On January 1st, 1888, 13 roads, 48.25 miles of track and 95 cars, and on July 1st, 1891, 354 roads, 2893 miles of track, and 4513 motor cars, showing a marvellous increase. He also pointed out what a great moral agent the electrical railways are. The great increase of population in our large cities, means an increase of the tenement house system instead of the cottage system, which means an increase in crime and death-rate. The labourer must live so as to be within easy reach of his work. He can spare but a fraction of his time, but a fraction of his day's wages in going to and from his work. It is admirably shown how, allowing 30 minutes morning and evening going to and from his work, he is restricted to a radius of three miles and an area of 28¼ square miles with the horse-cars, travelling at the rate of six miles per hour, while with electric cars going at nine miles per hour, slow for them, he has a radius of four and one-half miles and an area of 63½ square miles, within which to select a home. It will be seen then what a moral agent electricity is. He spoke of the comparatively few accidents by the electric roads in Boston. On the West End road 15 fatal accidents occurred in 1890, of which 10 were attributed to the horse-cars and five to the electric cars. He also spoke of the many enemies to which electric roads have been exposed, but also of the many that the now indispensable carriage and steam locomotive had to conquer before becoming a commercial success. He mentioned the Telephone Company as wanting to sue the electric roads for supposed infringement, when they used the ground return. (It would seem that the American Bell Telephone Co. wants the earth). He also showed the marked increase in the nett earnings of the electric over the horse road, showing a gain of 80% per car mile in one case. He ended by speaking of the rapid demand for electrical securities as an evidence of the growth.

The discussion that followed showed how much the electric railways had benefited both the cities through which they ran, and the company that operated them. It showed that although the electric cars had been run in many instances on the same schedule as with horses, yet the increase of traffic showed how the people appreciated the fact that their own pleasure was not at the expense of that wonderful medium which man called life.

A telegram was then read to the effect that all the investigations that were being made to ascertain the extent of the electrical industries in this country by the Census Bureau had been stopped, at least until the next session at Congress. Great indignation was manifested by the delegates at hearing this, and it was decided that a committee of not less than three, five if possible, be formed to go to Washington to see into the matter and to have a bill presented at the next session of Congress, asking for the appropriation to continue the work. It would be a shame indeed if the great increase in electrical industries within the last ten years should go unrecorded.

The report of the committee on Safe-wiring was then taken up, the rules being read separately so that any errors might be detected. Most of them passed, but there was some opposition on inside-wiring.

Mr. C. J. Field's paper on "Electric Railroad Construction and Operation" was then read. This paper was of great value to those interested in Electric Railway work, not perhaps from a popular point of view, as was Mr. Griffin's, but as a technical guide to operating and fitting up a railway. An interesting introduction, however, gave a brief historic sketch of the electric railway. He spoke of the steam plant, with advice as to the size of the engine to be employed, and the best method of connecting the dynamo to it. He condemned the use of the counter-shaft, and held that generators should be belted direct to the engine. Two interesting diagrams were given illustrating the rapid changes in load. He stated that the best engine to be used would be between a high-speed engine and a Corliss, which will combine many of the advantages of both. Two photoprints were given which illustrated an electric car of the Buffalo Railway Co., and the interior of the power station. Then followed some valuable statistics on the relative commercial economy of engines and costs, and the capacity of engine requisites for different generators. Then followed a description of the electric plant. He urged the use of large and efficient generators so as to prevent the over-loading, as is often the case with small machines. He stated that a fair basis on general conditions for 16 to 18 foot cars is 20 to 25 horse-power per car, and the cost for generating this power for 16 and 18 foot cars is three to five cents per car mile. He says that experience shows that a 32 or 33 foot car requires 50% more power, while a trail car attached to the motor car, adds 50% to the amount of work.

Then followed an account of electric cars and their equipment. He stated that the limit of length for a car run on a single track is 20 feet. He objects to the use of a vestibule on street cars as it prevents the free exit of the people. The cost of a single car including the car body truck and motors is from 3,000 to 3,500 dollars, and the cost of generating plant from 35 to 45 dollars per h. p. Valuable statistics were given of line construction, and a table of the cost of electric equipment for street-railway systems. The general construction of road-beds are girder-rails of from 60 to 100 lbs. per yard. Then followed an illustrative example showing how and with what profit an electric road may be operated. A description was then given of central stations in connection with Electric Railway work. The meeting then adjourned.

FIFTH SESSION, Friday, September 11th.

It was found necessary to hold a fifth session in order to transact all the business, and the delegates met to hear Mr. Ayer's valuable paper on "Some Details on the Care and Management of an Arc Lighting System as Practiced in the 'Municipal' of St. Louis." Mr. Ayer gave a paper describing arc lighting in St. Louis which contained much valuable information to those interested in the practical working of a large lighting station. The capacity of the plant was estimated at 6,000 arc lamps, of which 3,500 are operating daily. Two thousand of these lights are distributed over an area of 60 square miles for street lighting, while 1,500 more and a number of constant current motors are supplied to private consumers. The circuits supplying the lamps contain about 1,200 miles of wire. In the station the power consists of six 600 horse-power Corliss engines driving 65 60 light and 12 80-light 2,000 c. p. arc dynamos. In the boiler-room are nineteen 300 h. p. boilers. The trimmers are each supplied with a horse and cart and travel about 500 miles per day to supply carbons to the street lamps. He specified the following testing apparatus: two Thomson indicators for the engines, a recording steam gauge, two standard ammeters and a volt meter reading to 5,000 volts, a Wheatstone's bridge, magneto bells, etc. Tests are made very often to show that the apparatus is in good order. All the circuits are tested four times each day. The stopping and starting of engines, boilers, pumps, dynamos, and circuit are all recorded. The time recorded as lost during the first year's operations, due to open circuit, was 65 minutes. All circuits are more than 10 miles in length. He pointed out the marked loss when there is but a slight increase in current above the normal. Then followed valuable advice as to the testing carefully of the machines. He spoke of one case where the false reading on an ammeter resulted in the increase of the cost of fuel of about $16 per day. He also pointed out the advisability of having the consumer pay for his own wiring in arc lighting. A slight discussion followed on a few special points.

Mr. Warner's paper on "Different Forms of Carbons Used in Arc Lighting" was read, but no discussion followed. Mr. Warner gave an interesting account of the different forms of carbons used in the earlier arc lights. He pointed out that the form of cylinder or pencil carbon was used by Sir Humphrey Davey in his earliest experiments. Archereau, who was the first to produce a practical arc lamp, adopted the pencil form of carbon, while Wright and others used carbon discs brought edge to edge, and made to rotate as consumed. Wallace and Farmer used flat plates of carbon placed in a vertical plane one above the other, the arc forming between the edges as they are drawn apart, and shifting back and forth from one end to the other. Jablochoff used cylindrical pencils in his famous electric candle. He spoke of the double carbon lamp, produced by Mathias Day in 1874, and praised the ingenious way in which it was made. He also showed that Jablochoff, closely followed by Brush and Weston, took the lead in commercial arc lighting using cylindrical carbons. The first carbons produced for commercial use were some 32 inches in length. These were soon found to be too long, so were cut down to 22 inches. He recommends the use of the single carbon arc-lamp, using carbons 14 inches in length and $\frac{5}{8}$ inch in diameter, as a great deal of light is lost in the double-carbon lamp, owing to the shadows cast by the unused carbon. He stated an interesting experiment conducted by himself on two single carbon arc-lamps in series, one with ⅝ inch 14 inches carbons, and the other with carbons ½ inch, 12 inches. The lamps were adjusted to the same voltage. Photometric tests showed no difference in the two lights He ended by giving much valuable information relative to the cost, etc., of the double carbon arc-lamps.

This was the last paper to be read, after which some business was transacted. The members elected Sir William Dawson, Mr. F. R. Redpath and Prof. H. T. Bovey, honorary members of the Association. The city decided upon for holding the next Convention in February, was the home of the President, Buffalo, New York.

After many votes of thanks were passed to different people and companies for the kind hospitality showed to them, the meeting adjourned.

EXPLANATION OF ELECTRICAL WORDS, TERMS, AND PHRASES.

(From Houston's Dictionary.)

Boreal Magnet Pole.—A name sometimes employed in France for the south-seeking pole of a magnet, as distinguished from the austral, or north-seeking pole.

That pole of a magnet which points toward the geographical south.

If the earth's magnetic pole in the Northern Hemisphere be of north magnetism, then the pole of a needle that points to it must be of the opposite polarity, or of south magnetism. In this country we call the end which points to the north the *north-seeking end*, or the *marked pole*. In France, the end which points to the north is called the *austral pole*. Austral means south pole.

The austral is therefore the north-seeking pole, and the Boreal the south-seeking pole.

Boucherizing.—A process adopted for the preservation of wooden telegraph poles, by injecting a solution of copper sulphate into the pores of the wood.

Bound and Free Charge.—The condition of an electric charge on a conductor placed near another conductor, but separated from it by a medium through which *electrostatic induction* can take place.

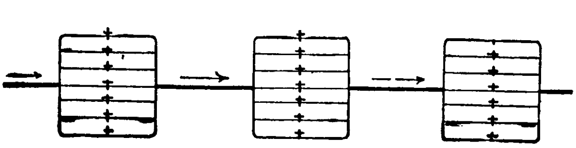


Fig. 61.

The charge, on a completely isolated conductor, readily leaves it when put in contact with a good conductor connected with the ground. The charge in this condition is called a *free charge*. When, however, the conductor is placed near another conductor, but separated from it by a medium through which induction can take place, a charge of the opposite name is induced in the neighboring conductor. This charge is held or bound on the conductor by the mutual attraction of the opposite charges.

To discharge a bound charge, both conductors must be simultaneously touched by any good conducting substance. The bound charge was formerly called *dissimulated* or *latent electricity*.

Box, Distribution, for Electric Arc Light Circuits.—A device by means of which arc and incandescent lights may be simultaneously employed on the same line, from a constant current dynamo electric-machine or other source.

A portion of the line circuit, whose difference of potential is sufficient to operate the electro-receptive device, as for example an incandescent lamp, is divided into such a number of multiple circuits as will provide a current of the requisite strength for each of the devices. In order to protect the remaining of these devices so interpolated, on the extinguishment of any of the devices, automatic cut-outs are provided which divert the current thus cut off through a resistance equivalent to that of the device.

A variety of distribution boxes are in use.

The character of circuit employed in connection with distribution boxes is shown in Fig. 61.

Brackets, Telegraphic, or Arms.—The supports or cross pieces on telegraph poles, provided for the insulators of telegraphic lines.

Telegraphic insulators are supported either on wooden *arms*, or on iron or metal *brackets*.

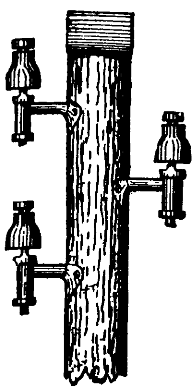


Fig. 65.

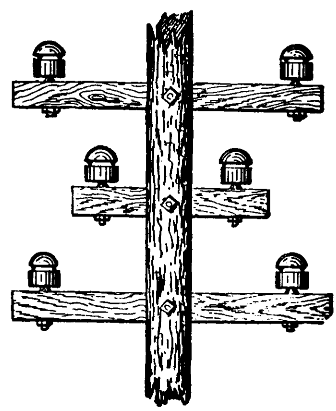


Fig. 66.

Fig. 65, shows a form of iron bracket. Fig. 66, shows a form of wooden arm.

Various well known modifications of these shapes are in common use.

Brake, Electro-Magnetic.—A brake for car wheels, the braking powers for which is either derived from electro-magnetism, or is thrown into action by electro-magnetic devices.

Electro-magnetic car brakes are of a great variety of forms. They may, however, be arranged in two classes, viz.:

(1) Those in which magnetic adhesion or the magnetic attraction of the wheels to the brake is employed.

(2) Ordinary brake mechanism in which the force operating the brake is thrown into action by an electro-magnet.

Branch-Block.—A device employed in electric wiring for taking off a branch from a main circuit.

Breaking Weight of Telegraph Wires.—The weight which when hung at the end of a wire will break it.

Ordinary copper wire will break at about 17 tons to the square inch of cross-section. Common wrought iron breaks at 25 tons to the square inch. When drawn, the breaking weight is often as great as 40 or 50 tons to the square inch. These figures are to be regarded as approximate only, since differences in the physical conditions of metals, as well as slight variations in their chemical composition, often produce marked differences in their breaking weights.

Bridge, Magnetic.—An apparatus invented by Edison for measuring magnetic resistance, similar in principle to Wheatstone's Electric Bridge.

The magnetic bridge is based on the fact that two points at the same magnetic potential fail, when connected, to produce any action on a magnetic needle. The magnetic bridge may be arranged as shown in Fig. 70, of four sides made of pure,

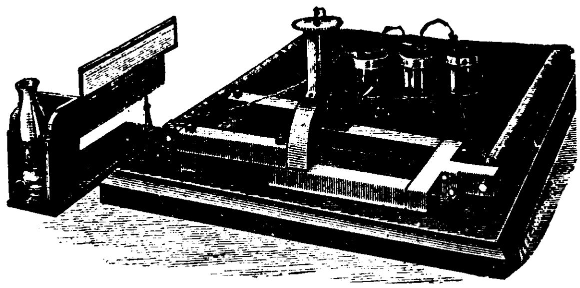


FIG. 70.

soft iron. The poles of an electro-magnet are connected, as shown, to projections at the middle of the short side of the rectangle. By this means a difference of magnetic potential is maintained at these points. The two long sides are formed of two halves each, which form the four arms of the balance. Two of these only are movable.

Two curved bars of soft iron, of the same area of cross-section as the arms of the bridge, rest on the middle of the long arms, in the arched shape shown. Their ends approach near the top of the arch within about a half inch. A space is hollowed out between these ends, for the reception of a short needle of well-magnetized hardened steel, suspended by a wire from a torsion head.

The movements of the needle are measured on a scale by a spot of light reflected from a mirror.

The electro-magnet maintains a constant difference of magnetic potential at the two shorter ends of the rectangle. If, therefore, the four bars, or arms of the bridge, are magnetically identical, there will be no deflection, since no difference of potential will exist at the ends of the bars between which the needle is suspended. If one of the bars or arms, however, be moved even a trifle, the needle is at once deflected, the motion becoming a maximum when the bar is entirely removed. If replaced by another bar, differing in cross-section, constitution, or molecular structure, the balance is likewise disturbed.

The magnetic bridge is very sensitive. It was designed by its inventor for testing the magnetic qualities of the iron used in the construction of dynamo-electric machines.

Broken Circuit.—An open circuit.

A circuit, the electrical continuity of which has been broken, and through which the current has therefore ceased to pass.

Brush Discharge.—The faintly luminous discharge that occurs from a pointed positive conductor.

Brush, Faradic.—An electrode in the form of a brush employed in the medical application of electricity.

The bristles are generally made of nickelized copper wire.

Brush Holders for Dynamo-Electric Machines.—Devices for supporting the collecting brushes of dynamo-electric machines.

As the brushes require to be set or placed on the commutator in a position which often varies with the speed of the machine, and with changes in the external circuit, all brush holders are provided with some device for moving them concentrically with the commutator cylinder.

Brushes, Adjustment of the—of Dynamo-Electric Machines.—Shifting the brushes into the required position on the commutator cylinder, either non-automatically by hand, or *automatically* by the current itself.

Brushes for Dynamo-Electric Machines.—Strips of metal, bundles of wire, or slit plates of metal, or carbon, that bear on the commutator cylinder and carry off the current generated.

Rotating brushes consisting of metal discs are sometimes employed. Copper is almost universally used for the brushes of dynamo-electric machines.

The brush shown at E, Fig. 71, is formed of copper wires, soldered together at the non-bearing end. A copper plate,

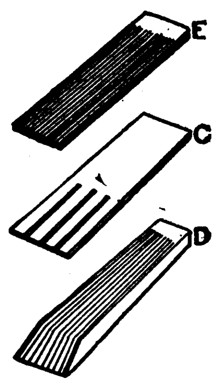


FIG. 71.

slit at the bearing end, is shown at C, and bundles of copper plates, soldered together at the non-bearing end, are shown at D.

The brushes should bear against the commutator cylinder with sufficient force to prevent jumping, and consequent burning, and yet not so hard as to cause excessive wear.

Buoy, Electric.—A buoy, on which luminous electric signals are displayed.

Burner, Electric.—A gas-burner whose gas-jet is electrically ignited.

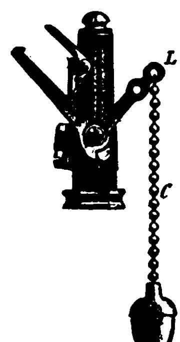


FIG. 72.

On pulling the pendant C, Fig. 72, a spark from a spark coil ignites the gas. On pulling the slide the gas is turned off.

Burner, Automatic Electric.—An electric device for either turning on the gas and lighting it, or for turning it off.

One push-button, usually a white one, turns the gas on and lights it by means of a succession of sparks from a spark coil. Another push-button, usually a black one, turns the gas off. Automatic burners are also made with a single button.

Burning at Commutator of Dynamo.—An arcing at the brushes of a dynamo-electric machine, due to their imperfect contact, or improper position, which results in loss of energy and destruction of the commutator segments.

Button, Push.—A device for closing an electric circuit by the movement of a button.

A button, when pushed by the hand, closes a contact, and thus completes a circuit in which some electro-receptive device is placed. This circuit is opened by a spring, on the removal of the pressure. Some forms of push-buttons are shown in Figs. 73 and 73*a*.

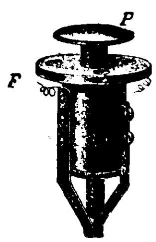


FIG. 74.

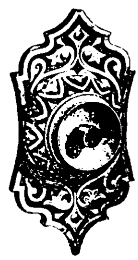


FIG. 73*a*.

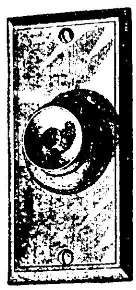


FIG. 73.

A *floor-push*, for dining-rooms and offices, is shown in Fig. 74.

B. W. G.—A contraction for Birmingham Wire Gauge.

Cable, Ærial.—A cable for telegraphic or telephonic communication, suspended in the air from suitable poles.

Cable, Electric.—A conductor containing either a single conductor, or two or more separately insulated electric conductors.

Strictly speaking, the word cable should be limited to the case of more than a single conductor. Usage, however, sanctions the employment of the word to indicate a single insulated conductor.

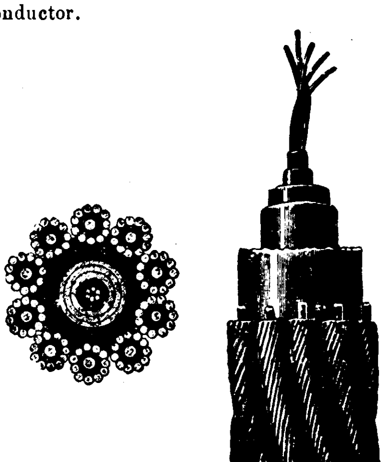


FIG. 75.

The conducting wire may consist of a single wire, of a number of separate wires electrically connected, or of a number of separate wires insulated from one another.

An electric cable consists of the following parts, viz. :

(1) The conducting wire or *core.*

(2) The insulating material for separating the several wires, and

(3) An *armor* or protecting covering, consisting of strands of iron wire, or of a metallic coating or covering of lead.

As to their position, cables are, *ærial, sub-marine,* or *underground.* As to their purpose, they are *telegraphic, telephonic,* or *electric light* and *power cables.*

Fig. 75 shows a form of submarine cable in which the armor is formed of strands of iron wire.

Cablegram.—A message received by means of a submarine telegraphic cable.

Cable Hanger.—A hanger or hook, suitably secured to the cable, and designed to sustain its weight by intermediately supporting it on iron or steel wires.

A cable hanger, or *cable clip,* is shown in Fig. 76.

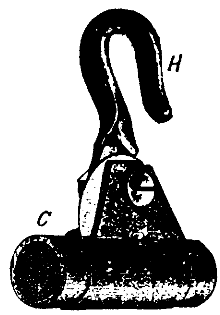


FIG. 76.

The weight, per foot, of an ærial cable is generally so great that the poles or supports would require to be very near together, unless the device of intermediate supports, by means of cable clips, were adopted.

Cables, Submarine.—Cables designed for use under water.

These are either *shallow-water,* or *deep-sea cables.* Gutta-percha answers admirably for the insulating material of the core. Various other insulators are also used.

Strands of tarred hemp or jute, known as the *cable-serving,* are wrapped around the insulated core, to protect it from the pressure of the galvanized iron wire armor afterwards put on. To prevent corrosion of the iron wire, it is covered with tarred hemp, galvanized, or otherwise coated.

THE POOR MAN'S LIGHT.

"At a recent meeting of the Western Gas Association one of its members, who by his own statement had never invested in an electric light plant, congratulated himself and comforted his fellow-gasometers by proving to their mutual satisfaction that the incandescent electric light is forever barred from becoming a successful competitor of gas. This statement has been so often repeated by those most ignorant of the subject that we feel some embarrassment in commenting on it at the present day. Nevertheless, one of the accompanying statements is worth a little discussion. The incandescent lamp is in the aforesaid paper stigmatized as "the rich man's light." Now, as touching the general question of economy the electric light is to-day in a very large number of places furnished at one cent per lamp hour, the equivalent of just about $2 per thousand feet for gas. As regards the economy of the matter, this statement ought to be quite sufficient. If the incandescent light is, as was stated, 64 per cent. more costly to pro duce than an equivalent amount of gas, the gas companies are, by their own confession, carrying on a business so extortionate that in the interests of civilization it ought to be regulated. The electric light to-day can and does compete with gas at ordinary prices in the most successful manner. As regards the allegation that it is the rich man's light, nothing can be more utterly false. We had the pleasure a year or two ago of inspecting an electric light plant in a small western town, looking over every foot of wire on the line and every lamp installed. So far from being the rich man's light, the service was extended into every quarter of the town, and lamps were installed in small cobbler shops and cheap lodging-houses ; in stables, cellars and outhouses. It was to be found everywhere where a good and convenient light would be wanted. While the incandescent lamp may be a convenience to the rich man, at the present price it is available for every one who would ever think of using gas. Among those who are too poor to use either illuminant, kerosene oil and candles are still employed, and it will be a long time before either electricity or gas can supersede these for such a class of consumers. But perhaps the most striking case of economy from the use of electricity comes in large solated plants such as are found in hundreds of office buildings and factories all over the country. It has been shown that with an installation of considerable size the cost per lamp installed per day, including every item of expenditure, can be reduced to less than 1¼ cents per lamp per day, and this even when a separate plant is operated by steam power. Where water is available the conditions for electric lighting are even more favorable."—*The Electrical World.*

A TUNNEL NOW MAKES THE UNITED STATES AND CANADA ONE.

The opening of the St. Clair River Tunnel, between Port Huron in Michigan, and Sarnia in Canada, last Saturday, brings interesting reminiscences to mind, and opens a door for imagination to make calculations for the future.

The "underground railway" by which many negroes escaped into Canada, was formed by boats. If such a tunnel as that just opened and dedicated had been in existence in slavery days, Uncle Tom's Cabin might have been written quite differently in many respects. And the absence of such a tunnel, at this very place too—between Port Huron and Sarnia —was the occasion of demonstratin the clever wit and ingenious mind of one of the greatest i ntists in the world to-day. To tell the story briefly : A telegraph operator of acknowledged ability (at the time), but unable to obtain a situation—because he was so clever and such a great experimenter, that people who could give him employment were afraid or jealous of him—was on the road "looking for a job." He happened to be in Port Huron when the telegraph wires between that city and the Canadian side were broken. They were in a great fix, and wanted to communicate with Sarnia very badly. But they were helpless. The young man "looking for a job" said that he could communicate with Sarnia ! They thought he was Old Nick himself, if not a crazy man, if he could communicate with Sarnia, when the wires were broken. But Edison—for it was him—jumped on the engine, and pulling the whistle lever called out, in the language of the telegraph (giving short and long sounds, by the whistle, instead of dots and dashes), "Sarnia, do you hear me !" This was repeated, but there was no response for some time. At last the ear of a telegraph operator, across the river, caught the sound "Sarnia, do you hear me ?" and at once jumped on the nearest engine, and whistled back, "I hear you." Thus they corresponded, and readily exchanged messages.

If Edison had not happened to be there at that time, there would have been no communication between Port Huron and Sarnia until boats would have crossed. The new tunnel brings the two cities into still closer relationship. And it will be a great convenience to those traveling by rail in and between the United States and Canada. Not only that, but as remarked by all the speakers at the opening ceremonies, this tunnel is destined to be an important factor in cementing the bond of unity and friendship between the two countries.

A tunnel between England and France has been repeatedly "projected" during several decades past. But the English are afraid to give the French such a convenient access to their "tight little island." And more than that, in case the French and Britishers should ever learn to "love thy neighbor as thyself" so much as to remove the barrier of suspicion and prejudice which precludes the chance of the building of such an international tunnel, the newly-whiskered Emperor William would very likely object to such a close union between England and France as strongly as Lord Salisbury objects to the opening of the Dardanelles for Russian war ships. But the opening of the Port Huron (or St. Clair) tunnel is the cause of great rejoicing between those immediately interested—the Americans and the Canadians—and all the world looks on complaisantly. Victoria and the rulers of her Queendom may not like to see Canada becoming so much attached to Brother Jonathan. But they bear it and grin, and will probably submit to the unavoidable as graciously as circumstances may admit when the United States and Canada become one.

A WONDERFUL ENGINEERING ACHIEVEMENT.

We have received the following description and history of the new tunnel:—

The St. Clair tunnel, on the Grand Trunk Railway of Canada, extending under the St. Clair River between Sarnia, Ont., and Port Huron, Mich., is one of the most remarkable engineering feats of the present day. The Grand Trunk Railway extended its lines to Chicago in 1880. About 5,000 miles of railway will use this tunnel. Previously steam ferries had been used. Their service has not been altogether satisfactory, because the river's current is very swift ; in winter there have been ice jams ; the railway had to deviate about six miles ; a bridge was impossible, owing to the nature of the ground and the opposition of the marine interests. The St. Clair River bears the most commerce of any stream in the world.

In 1884 preliminary surveys were made. Borings found the rock eighty-six feet below the level of the water ; the river's greatest depth 40.47 feet and its width nearly half a mile. The strata were yellow sand about two feet ; with sand and blue clay mixed about twelve feet, thence to the rock about twenty-one feet of blue clay. Plans and drawings were made. The St. Clair Tunnel Company was organized in 1886. At first the company thought of starting from immense shafts on the shore, and then working outward to the land approaches. In 1886 test shafts were sunk on each side of the St. Clair River ; drifts at right angles were started under the river ; water and gas stopped work. In 1887 these shafts were abandoned, and in 1888 large shafts were begun. The American one will be used as a ventilator.

The tunnel plants were erected back from the river ; in Michigan about 1,800 feet, in Ontario about 1,900 feet. Each plant contained a boiler house, hoisting or winding engines, a ventilating engine, an air blower with a capacity of 10,000 cubic feet of air per minute, a hydraulic pump for operating the rams, a machine shop with machines for tunnel work, a water pump for the pit, and an electric light plant. The tunnel will be lighted by electricity. The electric plant is in Sarnia, where permanent brick boiler and engine rooms have been erected.

The great cuttings for the approaches were commenced New Year's, 1889. Each cutting was made about sixty feet deep at the portal. The Canadian cutting at its broadest portion is 260 feet wide, the American about 200 feet wide. Into each pit inclined tracks were laid for engines to haul out the dirt. On the banks derricks were erected for hoisting the soil. In September, 1890, steam shovels began work on the cuttings. On each side of the river two shovels were used, each attended by an engine and train of flat cars. Several hundred men were employed night and day, lime lights being used at night, and the soil was removed in layers. The work of these shovels was greatly hindered by rains, and numerous landslides occurred.

THE HYDRAULIC MINING SHIELDS.

Because of water and quicksand the St. Clair tunnel could not have been constructed without the aid of hydraulic mining shields. Such shields have been used successfully in London, Chicago, Buffalo, Broadway tunnel, New York City, the Hudson River tunnel, and in other works. This shield is a cylinder, like a headless barrel. Its front end has sharpened edges to cut into the earth. The thin rear end is called the hood. The inside is braced with iron, both vertical and horizontal. Around the main walls are sets of hydraulic jacks. Each jack has a valve whereby it may be cut off at any time from the pump that supplies all the jacks. The masonry, or iron plates, of the tunnel, being built up within the thin hood of the shield, air is supplied to the jacks and the shield is forced ahead, usually the length of the pistons of the jacks, or about two feet. The shield having advanced, the men remove the soil from the front of the shield. Everything being in readiness the shield is again pushed forward, the tunnel walls built up, and the excavated soil removed.

Each of the St. Clair tunnel shields weighed eighty tons. They were made of steel, manufactured at Hamilton, and erected on a bank of a cutting. Each shield was circular, having an outside diameter of 21 feet and 6 inches, its length was 15 feet, and its thickness 1 inch. The shields were lighted by electricity. When erected the shields were rolled on wooden tracks into the cuttings. Each shield has two dozen hydraulic rams, operated by two men. The air pump might have exerted 3,000 tons pressure upon the shield, but the greatest pressure used was 1,700 pounds per square inch, 40 tons per ram and 960 tons on the shield. Each morning the direction of the shield was taken. By the pressure of the hydraulic rams the direction of the shields could be absolutely governed. How well is shown by the fact that when the shields met, after traveling 6,000 feet, they were exactly together.

The American shield was started July 11th, 1889, the Canadian September 21st, 1889, and they met at 11.30 p.m. August 30th, 1890. The shields' shells were left in the tunnel, and the tunnel walls laid up in them. The American had done the most work, and the easiest progress was towards Canada, the average being ten feet each day. The greatest advance in a day was 27 feet 10 inches. The time spent was less than in any similar tunnel construction. The American shield, in fourteen months, bored 3,313.85 feet; the Canadian, 2,686.10 feet. Sunday afternoon, August 24th, 1890, the two gangs of workmen talked and exchanged presents through the auger hole bored between the two shields. The first man through was Chief Engineer Hobson, followed by other officials, and then the whole working force. Three gangs of seventy-five men were employed in three shifts, each of eight hours.

At first long, thin spades were used to remove the clay. A workman whose trade was coopering took an old saw, bent it like a horseshoe, and made a knife with which he could do three men's work. His knife was then used as a model tool for cutting the clay. Two men, grasping the two handles, sliced out slabs of blue clay a yard long, and easily kept ahead of the layers of the tunnel lining. The clay was loaded upon flat cars by men. Mules or horses drew the clay-loaded cars out of the tunnel upon a tramway, on one of whose tracks the cars returned by their own gravity. The bed of this tramway was the blue clay, about two feet deep. When the tunnel was completed the removal of this clay bed consumed two months' time. At the tunnel entrance the clay cars were hoisted to the banks and dumped upon large railway flat cars, by which the soil was removed, and used in grading the new freight yards, where about twenty miles of side tracks were laid on each side of the river.

The tunnel walls are made of cast iron, suggested by Chief Engineer Hobson. In the circle are thirteen segments and a key. Each segment is 4 feet 10 inches long, 18 inches wide, and 2 inches thick, with flanges inside of $1\frac{3}{4}$ inches thick and 6 inches deep. In each segment were cast 32 holes, 4 in each end flange and 12 in each side flange. Through these holes passed steel bolts seven-eighths of an inch in diameter. In each section of the tunnel the circular joints required 157 bolts and the longitudinal joints required 56 bolts. The flanges took in a circle of 20 feet and 5 inches in diameter. The edges of the plates were planed in the machine shops near the tunnel entrances. Each plate was then heated and dipped in cold tar. This had been found better than to dip the cold iron into hot tar. Formerly the tar would not dry quick enough; later the tar was dried by the time the segments were cool. The segments were lifted to place by a circular crane revolving on a spindle in the center of the shield. This spindle had a vise at one end and a counterbalance weight at the other.

EFFECTS OF COMPRESSED AIR.

When the bed of the river was reached, quicksand and water made great trouble. For some time it was thought the tunnel might have to be abandoned. Compressed air was found a sure remedy. At the river line on each side, brick and cement, air-tight bulkheads were built across the tunnel. Each bulkhead had two air chambers, one on each side, 7 feet in diameter and 17 feet long, with air-tight doors at each end. Through each air chamber passed a car track. Inside the tunnel, beyond the bulkhead, work was begun under air pressure of 10 pounds to the square inch. From time to time the air pressure was gradually increased, until the men worked under an artificial pressure of 22 pounds per square inch, a total atmospheric pressure of 37 pounds per square inch, or about $2\frac{1}{2}$ atmospheres. On the Canadian side the highest air pressure was used because of quicksand. On the American side compressed air was used from April 7th, 1890; on the Canadian, May 20th, 1890.

The compressed air was shut off October 7th, 1890. It kept back the quicksand and water. Horses could not stand it, and mules had to draw the cars. The men had to be examined by the company's physician, and were required to have strong constitutions. Several deaths resulted from using the compressed air. About five minutes were needed to increase or diminish the pressure on the men passing through the air locks. A gang of men, or a car, would be admitted to the air chamber, the iron door closed, the air valve opened into the chamber, and the pressure regulated to that of the section inside or outside. Then the other doors could be opened without difficulty. Unless great care was used the men were attacked with the "benders," the symptoms being bleeding at the nose, mouth, and ears, and knees wabbling. Two ventilating tubes, each twenty inches in diameter, supplied pure air to the tunnel.

The tunnel walls are dry, and look like a ship's ribs. Pipes and wires are swung overhead. Safety platforms and ladders have been erected for the tunnel workmen and inspectors. Long lines of incandescent electric lights glimmer as far as can be seen. Brick and concrete walls were built in the lower third of the tunnel to prevent the brine from meat cars leaking on them and rusting. The brick work was plastered over. Nearly a million of steel bolts were tightened up and creosoted pine timbers were laid in the bottom of the tunnel. Beneath them are the three spaces for drainage, while above them is the railway track of standard gauge—4 feet 8½ inches. Extra heavy steel rails, 100 pounds to the yard, are used. The tunnel will drain itself into a pump shaft on the Canadian side. This shaft is 112 feet deep, 15 feet in diameter, and down to the rock. The water does not flow more than fifteen gallons per minute in the entire 6,000 feet of the tunnel. Rain and surface water is caught at the portals and pumped out.

The tunnel approaches have the same general appearance of solidity as the tunnel itself. On each side of the great cuttings are high and deep stone retaining walls. Each portal is 36 feet high and 148 feet wide, about 10 feet thick over the entrance of the tunnel, and about half that width at each end. Like the retaining walls the portals are made of rough, heavy limestone blocks. Over the entrance of each portal is inscribed "St. Clair, 1890." The diameter of the circle is 20 feet, and flush with the tunnel.

The average number of men employed was 700. In the tunnel eight hours made a day's work. The tunnel was estimated to cost $3,500,000, including plants, materials, and labor, and it required about that sum. It is likely that a second tunnel will be built near this. The present plants and experience will then be of additional value. The second tunnel will be of cast iron, as it is superior to brick and cement for similar tunnels.

DIMENSIONS, ETC., OF THE TUNNEL.

The St. Clair tunnel is 6,000 feet long. To the river's edge on the American side it is 1,716 feet; on the Canadian, 1,994 feet; under the river, 2,290 feet. The outside diameter of the tunnel is 21 feet, the inside 19 feet 10 inches. The tunnel nearest the river is 8.43 feet from the river. At its lowest point the top of the tunnel is 56.83 feet below the level of the river. From each portal to the river the grade is 1 foot down for every 50 feet; under the river, 1 foot down in every 1,000 feet toward the Canadian side to that drainage shaft. Over 2,000,000 cubic feet of soil were taken from the tunnel itself. The cast iron lining of the tunnel weighed 54,000,000 pounds. To fasten this lining 828,150 steel bolts seven-eighths of an inch in diameter were used. The Canadian open cutting is 3,193 feet long; the American, 2,532 feet long. The total length of the tunnel and its approaches is 11,725 feet.

The best kind of locomotive for this tunnel's use was discussed for some time. Coke engines were finally adopted. Three were built at the Grand Trunk shops of the "consolidated" pattern. Each engine can draw twenty-five loaded cars. One engine will be reserved for any possible accident, and one engine will be used on each side of the river. The car ferries will be discontinued.

In Port Huron August 20th, 1890, was recorded one of the largest mortgages ever given in Michigan. It was for $2,500,000. The St. Clair Tunnel Company gave it to secure bonds running fifty years and bearing 5 per cent annual interest, covering all the present property of the company. Rent and tolls can be collected for allowing other railways than the Grand Trunk system to use the tunnel.

Joseph Hobson, chief engineer of the company and builder of the tunnel, was born in Canada. From 1870 he was for three years the resident engineer of the International bridge at Buffalo over the Niagara River. Since 1875 he has been a chief engineer of the Great Western Railway of Canada and of the Grand Trunk Railway of Canada. In the St. Clair Tunnel works his able assistants have been: First assistant engineer in charge, Thomas E. Hillman; second assistant engineer, M. S. Blaiklock; mechanical superintendent, J. T. Eames; superintendent of excavation, Thomas J. Murphy.

It is believed that the Grand Trunk route, as thus improved, will offer facilities for through communication between Chicago and all points in the East which will be appreciated by passengers and shippers. There will be no more trouble from ice blocks or other obstruction in the river, and the best time will be made for traffic of all kinds.—*American Engineer*.

TRAINED AND EXPERIENCED ENGINEERS.

Every now and then some young man seeking a vocation in life asks us whether or not we would recommend a thorough training at a technical school as a necessary preliminary to entering some one of the many branches of engineering, says *Engineering News*, which goes on to say:

Many ingenious arguments are advanced in favor of combining study with practice in the field or work shop, and many names famous in the annals of engineering are quoted as belonging to men who have literally risen from the ranks, men like the elder Stephenson, Telford and Smeaton and the bulk of American civil engineers connected with the infancy of engineering in the United States. It is argued that study combined with experience is more efficient, and that facts gathered in practice teach more than dull books conned in a school-room.

In answer to the query above, we most emphatically recommend the most thorough scientific and general education at the best technical school available as an absolutely necessay preliminary step to successful practice in any branch of engineering. The time has passed for self-teaching and Stephensons, Telfords and Smeatons are rare in this day. Some young men, by reason of natural qualifications, untiring labor and personal chance or opportunity, may succeed in spite of the lacking early technical training. But these same men would have advanced more rapidly and risen higher had they had the opportunities referred to. The modern science of engineering is too broad, its detail too intricate and its progress too rapid for the untrained mind to keep pace with it; and education in those who adopt engineering as a profession is so general and the schools are so well equipped in teachers and apparatus, that even a phenomenally bright young man who starts out without these advantages will find himself sorely handicapped in the race for preferment. He may succeed, and some do succeed, but it is uphill work and a waste of useful energy.

Engineering is a many-sided profession, in the first place, and is utterly unlike its elder professional brothers in this respect. It enters in some of its many branches into our very life; it means modern progress in the world, and without it civilization would stop. Engineers—not divines, lawyers or doctors—are entitled practically to all the credit for the phenomenal material advance made in the civilized world in the last century, or even in the last half century, that spans an era of devlopement far surpassing in its scientific achievements any equal period in the world's history. It is the engineer—civil, mechanical, hydraulic, sanitary, mining or electrical—that has created our railways and canals, built our steamships and battle-ships, brings wholesome water to our doors, and sets thousands of spindles whirring by water power; drains, builds and paves our cities; improves the homes of rich and poor; turns our metals into finished products, and sets space and time at defiance, and lights our cities and carries their people by the power derived from electrical current. In fact, it is hard to say what an engineer is not, or what he may not be called upon to do.

Under these conditions it is naturally very difficult for either the young man, or his parents, to decide which of the many distinct paths of engineering it is best for him to enter; in which one he would be most likely to succeed. It is just here that the technical school, as now organized, has its real value, as an indicator of the best course to pursue. It is true that some of these schools are intended to train men for special branches of engineering, civil, mechanical, electrical, etc.; but as a rule the earlier courses of these institutions have for their purpose the development of the natural endowments, and do this by a general course of scientific training that is common to all branches of the profession, and essential as a foundation for any special branch. The work-shop, the laboratory and practice in the field now go hand in hand with theoretical teaching, and if the student has any natural inclination toward any special field of applied science, the fact is soon made evident to himself and to his teachers. With the direction once pointed out, it is then easy to find and follow to any end the path in life for which he is best fitted, and in which the student and the man is most likely to succeed. To-day there are schools for the advanced student in any one of the special branches of engineering that he may select, and the amount of knowledge gained before he commences to practice depends purely upon his own mental capacity and power for work.

But, say some young men, all this higher education costs money and we have not got it. Then our honest advice is, seek some other field of work where a technical training is not necessary. There are altogether too many self-taught engineers in the field now in this country, and in every section of the United States evidence can be found of their honestly intended but faulty work. Any young man can enter an engineering corps, learn to drive stakes, pull a chain and run a level or transit in time. By force of circumstances, opportunity or personal influence among the controlling spirits of a corporation, he may finally succeed to a position of some responsibility, and he then usually assumes that he is a full fledged civil engineer. So he is as far as the duties we have first enumerated are concerned, and he may do all of these well. But this is not civil engineering; it is scarcely worthy of being called the A B C of the art. Telford defines engineering as "the art of directing the great sources of power in nature for the use and convenience of man." To realize this definition the engineer must be well trained, he must know what other engineers have done, be mentally equipped so that he can follow their line of reasoning, profit by their experience, and be enabled to think and to plan for himself. He must know many things and know them well, and to obtain this information the technical school, with its trained and experienced staff of teachers, its laboratories, its work shops and its facilities for experiment and original research is essential.

Engineering is a profession of emergencies; the unexpected thing is always turning up and the engineer must be ready to meet them, and to meet them at once. He is often so situated that the best library of reference obtainable with money is of no avail, for it is inaccessible when wanted and time to consult is lacking. Vast interests or human life may depend upon what work he performs within a few hours, and to perform this work he must first know what to do and how to do it. It may be that he meets a difficulty that is unique in its way, or, if it has happened to other engineers, the methods pursued are unrecorded. But if he is well grounded in the leading principles of his profession, has a broad grasp on the field of engineering knowledge, has gained wisdom by the emergency experience of other engineers, even in other fields, and above all is sure of himself, he will quickly devise some way out of the scrape and gain renown and advancement for himself—though this latter does not always follow in this selfish age.

The timid engineer, who has no capital but the scanty knowledge he has picked up in the intervals of a busy life, may attempt to do something under these circumstances of danger, and he may possess sufficient force of character to put his plans into execution. But he usually does the wrong thing, commences at the wrong end, puts his props in the wrong place and generally bungles. And when he has time to hunt up authorities he appropriates a formula without understanding its limitations or controlling conditions, and builds upon a foundation of mental sand, so to speak, and is professionally a failure. It is true that some one else usually pays for his blunders; but as long as the employers of engineers are short sighted enough to intrust their work to the cheapest man who styles himself an engineer, we certainly cannot say that we are sorry for them. Corporations themselves are to-day mainly responsible for any bad work performed on their properties, for the reason that to-day competent, trained and experienced engineers can always be secured if the employer makes the attempt to seek them out and has the wisdom to pay for the best talent the work in question will demand. In brief, the real engineer of the modern times, to whatever branch of the profession he may belong, is not born an engineer, nor does he grow, as Topsy grew, to be an engineer. He must be made; and, like any other good machine, the finer the original material, the more perfect the workmanship and the more care used in adapting all the parts to the duty to be performed, the more certain and satisfactory will be the results obtained. * * * * * * *

But while the young engineer should be well educated and well trained, strong of limb, full of energy, brave and just, it is yet proper to say that the possession of all this training, combined with the other qualities, does not necessarily make an engineer. He must add to this years of hard, practical experience and always remember that there is no royal road to success in his profession. Many young men who have carried off the prizes of their college course and have graduated with all honors, forget this and at first feel disappointed because they are barred out from the higher walks in their branch of science. But if the right stuff is in them they soon recover and realize the fact that technical schools do not turn out engineers, but only young men more or less thoroughly equipped for rapidly gaining the practical knowledge that is only obtained outside of schools. What they have gained in the schools is the ability to better think for themselves and better appreciate and weigh the experience that must come later, and this ability is worth all the time and hard work it has cost. Work alone makes the really good engineer; but if a man has to waste his time in picking up in twenty years or more of self-tuition what he might have gained in a four or five years' course of technical training, when his brain was yet young and receptive, he will rarely pass beyond the middle stage of professional rank.

PHENOMENAL FRICTION.

BY JOHN H. COOPER.*

When making experiments during the month of February, 1891, with the Thurston railroad testing machine, I noticed the ease with which the axle box could be made to slide longitudinally upon the axle when the same was in motion.

The several boxes tried had about fourteen square inches of surface in contact with the axle; they were variously loaded, with weight from 262 pounds upwards, and the axle was running at speeds varying from 160 to 400 revolutions per minute.

One box could be moved by a pressure of one ounce when the axle was running, but required thirty-two pounds to move it when the axle was still.

Another box was moved by four ounces with motion, but required forty pounds without motion of the axle.

A third box under considerable pressure could be moved readily by a pull of six ounces, but fifty pounds would not start it when the axle was still, and, indeed, on trial, all the muscular force I could apply to it by my hands, with my foot against the machine, failed to start it.

A spring balance was used in these experiments, for pulling the box in a line parallel to the axle.

Here we employ forces anywhere from 160 to one, up to perhaps 1,000 to one, for moving the same body, under the same load and conditions, except that of the revolving or standing shaft beneath it.

This phenomenon of friction proved a marvel to all who witnessed it. The temptation was great to theorize upon the extraordinary performance, but no theory was offered in explanation of it. A practical suggestion was made, however, in reference to planer-bed motions, and the like, which drag so heavily upon their fixed ways. If, as then proposed, revolving shafts were placed in the bed-ways, and the table fitted to them, a pound pressure would move the table and its load back and forth on the revolving ways, where 1,000 pounds or more would be required to do this work upon the usual fixed V's of planers, as they are generally built.

Numerous applications of this principle will readily suggest themselves to the ingenious reader, when considering the necessity and the difficulties of moving dead loads, especially where ease and celerity of the movement may be required.

To the writer, this unique action, as if the loaded box were floating, was an instructive object lesson in mechanics.

INVENTORS OF PERPETUAL MOTION MACHINES.

Some of the most ingenious and persistent men are laboring on the hopeless task of devising perpetual motion appliances. Our educational system is in many respects responsible for so much mental energy being wasted upon fallacies. If natural philosophy and elementary mechanics received the attention in common schools that their importance demands, there would be fewer persons pestering their friends to supply funds for the development of apparatus intended to cheat nature's laws. Ignorance of the laws of nature is, no doubt, responsible for the majority of perpetual motion devotees, yet some men who are well educated become pursuers of the chimera. It is frequently difficult to understand the mechanical fallacies that creep over what are otherwise bright intellects. Electricity seems to be deceiving many men and leading them into the belief that by means of this mysterious force more power can be received than what is given. Since the electric lighting and electric transmission of power era began, there has been a great increase in the applications to the Patent Office for protection of what are electrical perpetual motion machines. For years the Patent Office income was considerably augmented annually by the receipt of fees from inventors of perpetual motion machines, but no fees are now accepted from men working on that kind of apparatus. A printed circular is sent to applicants saying that nothing short of a working mode would be received, and as the inventor never gets a model of this kind to work, he can do no more with the Patent Office. A correspondent of the St. Louis *Globe-Democrat* gives particulars of some curious recent perpetual motion cases. Mr. Keely has a good many imitators in a small way. A few months ago a New York lawyer went to Washington with parts of a machine, and had quite a controversy with the office because the patent was refused. He insisted that he had seen the machine in operation, that it was running day after day, and keeping a cider press going to boot. There was no deviating from the rule. The lawyer went back to New York, saying that he would produce the machine. He was not seen again until the centennial celebration lately, when he reminded the examiner of the case and told him how he had been fooled. At the time of making application the lawyer really believed that his client had discovered the long-sought principle. But when he got back to New York and told that the patent had been refused, the client confessed. The perpetual motion was no motion at all. Power was concealed in the cider press. It ran the press, and the press made the perpetual motion machine go too. The inventor had been charging 10 cents admission to see perpetual motion. He had fooled the public and his lawyer, and he hoped to slip through a claim.—*National Car and Locomotive Builder.*

THE SYSTEM OF MILITARY DOVE COTES IN EUROPE.*

France.—The history of the aerial postal service and of the carrier pigeons of the siege of Paris has been thoroughly written, and is so well known that it is useless to recapitulate it in this place. It will suffice to say that sixty-four balloons crossed the Prussian lines during the war of 1870–1871, carrying with them 360 pigeons, 302 of which were afterward sent back to Paris, during a terrible winter, without previous training, and from localities often situated at a distance of over 120 miles. Despite the shooting at them by the enemy, 98 returned to their cotes, 75 of them carrying microscopic despatches. They thus introduced into the capital 150,000 official despatches and a million private ones reduced by photo-micrographic processes. The whole, printed in ordinary characters, would have formed a library of 500 volumes. One of these

* In the May *Journal of the Franklin Institute.*

* Continued from *Scientific American* of July 11, p. 23.

carriers, which reached Paris on the 21st of January, 1871, a few days previous to the armistice, carried alone nearly 40,000 despatches.

The pigeon that brought the news of the victory of Coulmiers started from La Loupe at ten o'clock in the morning on the 10th of November, and reached Paris a few minutes before noon. The account of the Villejuif affair was brought from Paris to Tourcoing (Nord) by a white pigeon belonging to Mr. Descampes. This pigeon is now preserved in a stuffed state in the museum of the city. The carrier pigeon service was not prolonged beyond the 1st of February, and our winged brothers of arms were sold at a low price at auction by the government, which, once more, showed itself ungrateful to its servants as soon it no longer had need of their services. After the commune, Mr. La Perre de Roo submitted to the president of the republic a project for the organization of military dove cotes for connecting the French strongholds with each other. Mr. Thiers treated the project as chimerical, so the execution of it was delayed up to the time at which we saw it applied in foreign countries.

FIG. 1.—THEORETIC MAP OF THE FRENCH SYSTEM OF MILITARY DOVECOTES.

In 1877, the government accepted a gift of 420 pigeons from Mr. De Roo, and had the Administration of Post Offices construct in the Garden of Acclimatization a model pigeon house, which was finished in 1878, and was capable of accommodating 200 pairs.

At present, the majority of our fortresses contain dove cotes, which are perfectly organized and under the direction of the engineer corps of the army.

The map in Fig. 1 gives the approximate system such as it results from documents consulted in foreign military reviews.

According to Lieutenant Gigot, an officer of the Belgian army, who has written a very good book entitled *Science Colombophile*, a rational organization of the French system requires a central station at Paris and three secondary centers at Langres, Lyons and Tours, the latter being established in view of a new invasion.

As the distance of Paris from the frontier of the north is but 143 miles at the most, the city would have no need of any intermediate station in order to communicate with the various places of the said frontier. Langres would serve as a relay between Paris and the frontier of the northeast. For the places of the southeast it would require at least two relays, Lyons and Langres, or Dijon.

As Paris has ten directions to serve, it should therefore possess ten different dove cotes of 720 birds each, and this would give a total of 7,200 pigeons. According to the same principle, Langres, which has five directions to provide for, should have 3,600 pigeons.

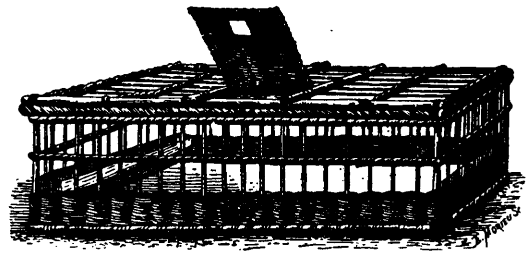


FIG. 2.—BASKET FOR CARRYING PIGEONS.

Continuing this calculation, we find that it would require 25,000 pigeons for the dove cotes as a whole appropriated to the frontiers of the north, northeast, east and southeast, without taking into account our frontiers of the ocean and the Pyrenees.

A law of the 3d of July, 1877, supplemented by a decree of the 15th of November, organized the application of carrier pigeons in France.

One of the last enumerations shows that there exist in Paris 11,000 pigeons, 5,000 of which are trained, and in the suburbs 7,000, of which 3,000 are trained. At Roubaix, a city of 100,000 inhabitants, there are 15,000 pigeons. Watrelos, a small neighbouring city of 10,000 inhabitants, has no less than 3,000 carrier pigeons belonging to three societies, the oldest of which, that of Saint-Esprit, was founded in 1869.

In entire France, there are about 100,000 trained pigeons, and forty-seven departments having pigeon fancying societies.

Germany.—After the war of 1870, Prussia, which had observed the services rendered by pigeons during the siege of Paris, was the first power to organize military dove cotes.

In the autumn of 1871, the Minister of War commissioned Mr. Lentzen, a very competent amateur of Cologne, to study the most favorable processes for the recruitment, rearing and training of carrier pigeons, as well as for the organization of a system of stations upon the western frontier.

In 1872, Mr. Bismarck having received a number of magnificent Belgian pigeons as a present, a rearing station was established at the Zoological Garden of Berlin, under the direction of Dr. Bodinas.

In 1874, military dove cotes were installed at Cologne, Metz Strassburg and Berlin. Since that time there have been organized, or at least projected, about fifteen new stations upon the frontier of France, upon the maritime coasts of the north, or upon the Russian frontier.

Berlin remains the principal rearing station, with two pigeon houses of 500 pigeons each ; but it is at Cologne that is centralized the general administration of military dove cotes under Mr. Lentzen's direction. The other stations are directly dependent upon the commandant of the place, under the control of the inspector of military telegraphy. The Wilhelmshaven dove cote, by way of exception, depends upon the Admiralty. In each dove cote there is a subofficer of the engineer corps and an experienced civil pigeon fancier, on a monthly salary of ninety marks, assisted by two orderlies. In time of war, this *personnel* has to be doubled and commanded by an officer.

The amount appropriated to the military dove cotes, which in 1875 was about 13,000 francs, rose in 1888 to more than 60,000 francs.

As a rule, each dove cote should be provided with 1,000 pigeons, but this number does not appear to have been yet reached except at Thorn, Metz and Strassburg.

Germany has not confined herself to the organization of military dove cotes, but, like other nations, has endeavoured to aid and direct pigeon fancying, so as to be able, when necessary, to find ready prepared resources in the civil dove cotes. The generals make it their duty to be present, as far as possible, at the races of private societies, and the Emperor awards gold medals for flights of more than 120 miles.

On the 13th of January, 1881, nineteen of these societies, at the head of which must be placed the Columbia, of Cologne, combined into a federation. At the end of the year the association already included sixty-six societies. On the 1st of December, 1888, it included seventy-eight, with 52,240 carrier pigeons ready for mobilization.

The first two articles of the statutes of the Federation are as follows :

"I. The object of the Federation is to unite in one organization all societies of pigeon fanciers in order to improve the service of carrier pigeons, which, in case of war, the country must put to profit.

"II. The Federation therefore proposes : (*a*) To aid the activity of pigeon fancying societies and to direct the voyages of the societies according to a determined plan ; (*b*) to form itinerant societies and on this occasion to organize expositions and auction sales of pigeons ; (*c*) to maintain relations with the Prussian Minister of War ; (*d*) to obtain diminutions and favors for transportation ; (*e*) to make efforts for the extermination of vultures ; (*f*) to obtain a legal protection for pigeons ; and (*g*) to publish a special periodical for the instruction of fanciers."

Italy.—The first military dove cote in Italy was installed in 1876, at Ancona, by the twelfth regiment of artillery. In 1879, a second station was established at Bologna. At present there are in the kingdom, besides the central post at Rome, some fifteen dove cotes, the principal ones of which are established at Naples, Gaeta, Alexandria, Bologna, Ancona and Placenza. There are at least two on the French frontier at Fenestrella and Exilles, and two others in Sardinia, at Cagliari and Maddalena. The complete system includes twenty-three ; moreover, there are two in operation at Massoua and Assab.

The cost of each cote amounts to about 1,000 francs. The pigeons are registered and taken care of by a pigeon breeder (a subofficer) assisted by a soldier. The head of the service is Commandant of Engineers Malagoli, one of the most distinguished of pigeon fanciers.

We represent in Fig. 2 one of the baskets used in France for carrying the birds to where they are to be set free.—*La Nature.*

BIG FACTS IN LITTLE SPACE.

About 450 B. C. the Ionians first introduced the present system of writing from left to right. Previous to the above date from right to left prevailed.

There are at least 10,000,000 nerve fibers in the human body.

Three and a half millions of people are always on the seas of the world.

One half the people that are born die before the age of 16.

A recent survey has established the number of glaciers in the Alps at 1,155, of which 249 have a length of more than four and three quarter miles.

A grain of musk will scent a room for twenty years, and at the end of that time will not show it has diminished in the least.

A grain of carmine or half a grain of aniline will tinge a hogshead of water so that a strong microscope will detect coloring matter in every drop.

A luminous buoy has been invented, the light of which is produced by phosphuret of calcium, and is visible two and a half miles away.

The proportion of Anglo-Saxon words in the English Bible is 97 percent of the whole.

The receipts of the French treasury are larger than those of any other civilized nation.

It takes about three seconds for a message to go from one end of the Atlantic cable to the other. This is about 700 miles a second.

Only one person in a thousand dies of old age.

An inch of rain means 100 tons of water on every acre.

The smallest known insect, the Pteratomas Putnamii, a parasite of the ichneumon, is but one ninetieth of an inch in length.

The thickness of the human hair varies from the two hundred and fiftieth to the six hundredth part of an inch.

Blonde hair is the finest and red hair the coarsest.

The force required to open an oyster appears to be 1,319½ times the weight of the shelless creature.

It has been calculated that there are about 200,000 families living in London on about £1 a week.—*New York World.*

AN IMPROVEMENT WHICH FAILED TO IMPROVE.

Mr. Metcals, in a discussion at the late meeting of the American Society of Civil Engineers, concerning water supply, said : "We have had at times a great deal of trouble in getting a water supply for our establishment because of the floods in the Allegheny River, and a couple of years ago I thought I would make a great improvement. I had the Philadelphia Company send their dredge up and dredge a place some 10 or 15 ft. deep in the bed, and near the mouth of the Allegheny River. I then had a heavy timber crib built in the space thus dredged, and sunk our suction pipes into this crib. We got a beautifully clear water, and thought we had done a very great thing, but in a few days our whole concern was up in arms. A great many complaints were made, and they told me they could not get the boilers clean. The man in charge of the boilers said if he had to use the water he would give up the job, because he knew the result would be an explosion. Of course, I thought they were simply pumping out a little loose sand, but I had Professor Langley take up the matter and analyze the water to see if there was any real cause for trouble. The Allegheny River water is a very soft, delicious water, and we found that we had in that short distance of 12 or 15 feet struck a sub-river of lime water some 12 feet below the Allegheny, which contained thirteen times as much impurity as the muddiest river water we could get from a dirty flood stage in the river. So we were obliged to destroy the crib at considerable expense."—*The Railway Review.*

The maximum safe velocity of cast iron fly wheels should not exceed a rim speed of 80 feet per second.