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TRACTIVE FORCE OF LEATHER BELTS ON PULLEY FACES.*

BY SCOTT A. SMITH, PROVIDENCE, R.I.

It is of the highest value to users of leather belts to know the exact conditions which give the greatest tractive force of belts on pulley faces; in immediate connection with this, it is essential to have knowledge of what constitutes the best leather belting.

It is the opinion of the writer that the best belts are made from all oak-tanned leather, and curried with the use of cod oil and tallow, all to be of superior quality. Such belts have continued in use thirty or forty years when used as simple driving-belts, driving a proper amount of power, and having had suitable care.

In the best methods of currying, only a very small quantity of the stearine of tallow enters into the leather; the oleine of the tallow and cod oil, during a period of four weeks employed in a suitable currying process, oxidize under the influence of heat, moisture and much hand and machine labor intelligently used, and become, or partake of the nature of a gum or varnish, most intimately united with fibres which interlace in all directions.

Such leather contains no free oil, which would, if of animal or vegetable origin, have a natural tendency to generate free acid injurious to the fibres. Belt leather thus made has a supple character, with a little elasticity and compressibility which eminently fits it for tractive use on a pulley face.

When a new belt is put to use with the flesh side to the pulley, there is on it a certain quantity of stearine from the tallow (rubbed down to give smoothness to that side); this grease acts, or aids, by increasing the surface of contact, to give an extra tractive quality to the leather. If the grain side is run to the pulley face, then, in the first use of the belt, there is more tendency to slip, owing to the absence of grease on the surface, and also to the fact that the grain is hard; and in case of small diameters of pulleys, the belt face is wrinkled, thus it is less in a condition to be brought into intimate contact, under pressure, with the pulley face over its whole contact surface, than is the softer flesh side. The stearine on the surface of the flesh side, and the softness of its face, operate to exclude air from between the two surfaces, thus affording the benefit of atmospheric pressure, the strongest element in its tractive force, to hold the belt to the pulley face. In addition, when the two surfaces of leather and iron come together, on one or both of which there is a semi-fluid to interpenetrate into the pores of the two faces (providing there is a minimum of this material, or only sufficient for this interpenetration) then this material becomes an impediment to the slipping of the belt to the extent of the cohesion to, or affinity for, the iron and leather.

This statement, in relation to the action of stearine on the flesh side of leather, and the running of that side to a pulley face, is not given in the sense of an approval of either the one or the other, but to illustrate by a familiar fact. Stearine has no legitimate place on, or in, leather; also the flesh side should not be run to the pulley face, for the reason that the wear from contact with the pulley should come on the grain side, as that surface of the belt is much weaker in its tensile strength than the flesh side; also as the grain is hard it is more enduring for the wear of attrition; further, if the grain is actually worn off, then the belt may not suffer, in its integrity, from a ready tendency of the hard grain side to crack.

The most intimate contact of a belt with a pulley comes, first, in the smoothness of a pulley face, including freedom from ridges and hollows left by turning tools. Second: In the smoothness of the surface and evenness in the texture, or body, of a belt. Third: In having the crown of the driving and receiving pulleys exactly alike; as nearly so as is practicable, in a commercial sense. Fourth: In having the crown of pulleys not over ⅛" for a 24" face, that is to say, that the pulley is not to be over ¼" larger in diameter in its centre. Fifth: In having the crown other than two planes meeting at the centre. Sixth: The use of any material on, or in, a belt, in addition to those necessarily used in the currying process, to keep them pliable or increase their tractive quality, should wholly depend upon the exigencies arising in the use of belts; and the use of such material may justly be governed by this idea, that it is safer to sin in non-use than in overuse. Seventh: With reference to the lacing of belts, it seems to be a good practice to cut the ends to a convex shape by using a former, so that there may be a nearly uniform stress on the lacing through the centre as compared with the edges. For a belt 10" wide, the centre of each should recede 1·10".

An impediment to the just use of leather belting, in minor cases, comes from the fact that many manufacturers of machin-

* Presented at the XIXth Meeting, Erie, Pa., 1889, American Society of Mechanical Engineers.

ery will adhere to the custom of putting too small receiving pulleys on to their machines, to indicate to the purchaser that little power is required to operate them. I have a feeling of pride in having the acquaintance of an eminently practical man who takes off a pulley 6" diameter by 4" face on a circular-saw arbor, and substitutes a pulley 9" in diameter by 6" face.

A few words as to hemlock-tanned leather, or leather tanned by the use of half hemlock and half oak bark. I do not consider them as worthy of much consideration, as many makers of that class of belting stock have been obliged to abandon its manufacture during the past forty years. It is a less costly and less enduring product. It goes without saying that a well-made "hemlock" belt is better than a poorly-made "oak" belt; duly considering all the processes involved in the making of each.

I would maintain that a skilled maker of oak-tanned belting can meet any and all legitimate requirements, whatever they may be. Some uses of a belt demand that it shall be much softer than for other purposes; some that it shall be elastic; other cases need a very rigid and non-elastic belt. For quarter-twist belts, owing to the firmness of oak-tanned leather, the belts should be specially shaped by the maker for that use, both in the length of the belt and at the ends.

Referring again to the subject of oils on leather; mineral oils always act to negative oxidations of the oils in the currying process; hence they are detrimental for that use. If added after the currying proeess is completed, then they tend to undo the currying by softening the oxidized oils.

A question not to be ignored relates to the action of air and other influences in keeping belts from full contact with the top side of a receiving pulley, when belts are run at very high speeds; this is caused by the massing of air at this point; by excessive crowns in pulleys, giving much convexity to the belt to hold air on or in its concave side; by the rigid character of many belts, and by centrifugal force.

Much leather belting is made, which, when finished, has a very rigid character. It has gone into the hands of users in that condition for these reasons: First, because a desire has grown with some users to have belts extremely rigid against stretching—apparently forgetting that such rigidity ensures that a belt shall have a comparatively short life. Second, to make a belt very supple and very uniform, in its body, and over its whole surface, necessitates expensive methods in currying. The continued demand for lower and lower prices has induced the leaving out of that amount of careful hand labor which always gives suppleness to leather, if otherwise well qualified; and in place of it has come a "machine" surface finish, which, to the eye, passes for the genuine article. This suppleness—sometimes called mellowness—gives to the leather due pliability, and such belts run satisfactorily at high speeds.

While the "suppleness" of belt leather has been denominated "mellowness," it should be stated that there is a resistance to flexion, in the best leather, due to its components of fibres, interlaced, in all directions, and a body of flexible gum, which while it readily bends, yet it as readily returns to its initial shape; but the best is fully appreciated only through experience.

Rigid belts are sometimes made pliable by saturation with "belt oil," but the inevitable result, in time, is a disorganized belt; slipping will come, and the addition of more oil only results in its acting as a lubricant, by piling up on the surface.

There is some doubt in my mind as to the desirability of perforating belts, or the drilling of pulley faces, to overcome the difficulty mentioned, so far as it comes from the air, which is not so much a real difficulty when properly made belts are used as it is with rigid belts.

Free oils added to curried leather, give "momentary" added strength by filling all the pores to distention, thus locking fibres to place; and by softening the fibres and allowing a strain—for instance, at lace holes—to be distributed over very many fibres.

As friction is due—largely—to the unevenness of two surfaces in contact under motion, and as the best tractive quality of belts comes from the evenness and smoothness of the two surfaces of belt and pulley face, it easily follows, from what I have said, that the value of the tractive force of a belt on a pulley face is due, first, to atmospheric pressure; second, to the tractive adhesion of the leather fibres and the oxidized oil of the currying process.

THE PREVENTION OF ACCIDENTS FROM RUNNING MACHINERY.

A German commission was appointed to investigate accidents in mills and factories, and draw up a series of rules for their prevention. Some of these rules are as follows:

SHAFTING.

All work on transmissions, especially the cleaning and lubricating of shafts, bearings and pulleys, as well as the binding, lacing, shipping and unshipping of belts, must be performed only by men especially instructed in, or charged with such labors. Females and boys are not permitted to do this work.

The lacing, binding or packing of belts, if they lie upon either shaft or pulleys during the operation, must be strictly prohibited. During the lacing and connecting of belts, strict attention is to be paid to their removal from revolving parts, either by hanging them upon a hook fastened to the ceiling, or in any other practical manner; the same applies to smaller belts, which are occasionally unshipped and run idle.

While the shafts are in motion they are to be lubricated, or the lubricating device examined only when observing the following rules: (*a*) The person doing this labour must either do it while standing upon the floor, or by the use of (*b*) Firmly located stands or steps, especially constructed for the purpose, so as to afford a good and substantial footing to the workman. (*c*) Firmly constructed sliding ladders running on bars. (*d*) Sufficiently high and strong ladders, especially constructed for this purpose, which, by appropriate safe guards (hooks above or iron points below), afford security against slipping.

The cleaning and dusting of shafts, as well as of belt or rope pulleys mounted upon them, is to be performed only when they are in motion, either while the workman is standing: (*a*) on the floor; or (*b*) on a substantially constructed stage or steps; in either case, moreover, only by the use of suitable cleaning implements—duster, brush, etc.—provided with a handle of suitable length. The cleaning of shaft bearings, which can be done either while standing upon the floor, or by the use of the safe guards mentioned above, must be done only by the use of long-handled implements. The cleaning of the shafts, while in motion, with cleaning waste or rags held in the hand, is to be strictly prohibited.

All shaft bearings are to be provided with automatic lubricating apparatus.

Only after the engineer has given the well understood signal, plainly audible in the work rooms, is the motive engine to be started. A similar signal shall also be given to a certain number of work rooms if only their part of the machinery is to be set in motion.

If any work other than the lubricating and cleaning of the shafting is to be performed while the motive engine is standing idle, the engineer is to be notified of it, and in what room or place such work is going on, and he must then allow the engine to remain idle until he has been informed by proper parties that the work is finished.

Plainly visible and easily accessible alarm apparatus shall be located at proper places in the work-rooms to be used in cases of accident to signal to the engineer to stop the motive engine at once. This alarm apparatus shall always be in working order, and of such a nature that a plainly audible and easily understood alarm can at once be sent to the engineer in charge.

All projecting wedges, keys, set-screws nuts, grooves, or other parts of machinery having sharp edges, shall be substantially covered.

All belts and ropes which pass from the shafting of one story to that of another, shall be guarded by fencing or casing of wood, sheet-iron, or wire netting four feet six inches high.

The belts passing from shafting in the story underneath and actuating machinery in the room overhead, thereby passing through the ceiling, must be inclosed with proper casing or netting corresponding in height from the floor to the construction of the machine. When the construction of the machine does not admit of the introduction of casing, then at least, the opening in the floor through which the belt or rope passes, should be inclosed with a low casing at least four inches high.

Fixed shafts, as well as ordinary shafts, pulleys and fly wheels, running at a little height above the floor, and being within the locality where work is performed, shall be securely covered.

These rules and regulations, intended as preventions of accidents to workmen, are to be made known by being conspicuously posted in all localities where labor is performed.

ENGINEERS.

The attendant of a motive engine is responsible for the preservation and cleaning of the engine, as well as the floor of the engine room. The minute inspection and lubrication of the several parts of the engine is to be done before it is set in motion. If any irregularities are observed during the performance of the engine, it is to be stopped at once, and the proper person informed of the reason.

The tightening of wedges, keys, nuts, etc., of revolving or working parts, is to be avoided as much as possible during the motion of the engine.

When large motive engines are required to be turned over the dead point by manual labor, the steam supply valve is to be shut off.

After stoppage, either for rest or other cause, the engine is to be started only after a well understood and plainly audible signal has been given. The engineer must stop his engine at once upon receipt of an alarm signal.

The engineer has the efficient illumination of the engine room, and especially the parts moved by the engine, under his charge. The engineer must strictly forbid the entrance of unauthorized persons into the engine room.

An attendant of a steam or other power motor, who is charged with the supervision of the engine as his only duty, is permitted to leave his post only after he has turned the care of the engine over to the person relieving him in the discharge of his duties.

The engineer is charged with the proper preservation of his engine and means therefor. He must at once inform his superiors of any defect noticed by him.

The engineer on duty is permitted only to wear closely-fitting and buttoned garments. The wearing of aprons or neckties with loose, fluttering ends is strictly prohibited.

GEARING.

Every work on gearing, such as cleaning and lubricating shafts, bearers, journals, pulleys and belts, as well as the tying, lacing and shipping of the latter, is to be performed only by persons either skilled in such work, or charged with doing it. Females and children are absolutely prohibited from doing such work.

When lacing, binding, or repairing the belts they must either be taken down altogether from the revolving shaft or pulley, or be kept clear of them in an appropriate manner. Belts unshipped for other reasons are to be treated in the same manner.

The lubricating of bearings and the inspection of lubricating apparatus must, when the shafting is in motion, be performed either while standing upon the floor, or by the use of steps or ladders, specially adapted for this purpose, or proper staging or sliding ladders. The lubrication of wheel work and the greasing of belts and ropes with solid lubricants is absolutely prohibited during the motion of the parts.

In case of accident any workman is authorized to sound the alarm signal at once by the use of the apparatus located in the room, for this purpose, to the engineer in charge.

The following rules, classified under proper sub-heads, are published by the *Technische Vereiu* at Augsburg.

TO PREVENT ACCIDENT BY THE SHAFTING.

While the shafts are in motion it is strictly prohibited : (*a*) To approach them with waste or rags in order to clean them. (*b*) In order to clean them, to raise above the floor by means of a ladder or other convenience.

It is allowable to clean the shafting and pulleys only while in motion.

These parts of the machinery must be cleaned by means of a long handled brush only, and while standing upon the floor.

The workmen charged with these or other functions about the shafting, must wear jackets with tight sleeves, and closely buttoned up; they must wear neither aprons nor neckties with loose ends.

Driving pulleys, couplings and bearings are to be cleaned only when at rest.

This labor should, in general, be performed only after the close of the day's work. If performed during the time of an accidental idleness of the machinery, or during the time of rest, or in the morning before the commencement of work, the engineer in charge is to be informed.

VARNISH FOR CLEANING AND PRESERVING HARNESS AND OTHER LEATHER GOODS.

Four ounces of shellac, half an ounce of camphor, and one ounce of resin are dissolved in one pint of methylated spirit and shaken at intervals for 48 hours. The mixture is then colored according to the kind of leather with which it is to be used. Other resins, solvents, and proportions may be adopted.

FIG. I.—FURNACES FOR THE MANUFACTURE OF SODIUM.

THE MANUFACTURE OF ALUMINIUM FROM CRYOLITE.

We give herewith three engravings illustrating the manufacture of aluminium from cryolite at the works of the Alliance Aluminium Company, at Wallsend, near Newcastle-on-Tyne. The works have been erected under the direction of Dr. Netto, to whom the method for obtaining aluminium from cryolite by the direct action of sodium without the use of chlorine is due. Our illustration (Fig. 1) represents a battery of furnaces employed for the preparation of the sodium required in the process. They are built in continuous blocks, each furnace occupying a space 8ft. by 8ft. by 6ft. high. In the centre of each furnace is fixed a cast iron retort 3ft. high and 2ft. wide at its broadest part, with a spout projecting from its base, through which the liquid slags are drawn as the retort fills. The retort is covered by a cylindrical box luted on gas-tight with slaked lime, and containing orifices through which the mixture to be treated is fed into the retort. It is also fitted with a tube, to which is attached the sodium condenser. After heating the retort a charge of gas carbon is introduced and brought to a bright red heat, and then molten caustic soda (previously melted in a cast iron vessel by means of the waste heat of the furnace) is allowed to slowly run through a siphon on to the surface of the hot carbon. In a few minutes thick clouds of vapours issue from the retort, which readily kindle and burn with an intense yellow flame at the mouth of the condenser. The flow of caustic soda is regulated by the workmen, who judge of the progress of the reaction from the intensity and volume of these flames. The metallic sodium drops from the mouth of the condenser into shallow iron trays, from which it is quickly transferred to air-tight iron drums for further use. Each retort makes about 60lbs. of sodium per diem, but has to be constantly watched to prevent the condenser from becoming plugged with the condensed sodium, which has therefore to be removed by an iron rod from time to time. The carbonate of soda is removed from the retort from time to time, and about 1,600lbs. of sodium may be manufactured from one retort before it is necessary to replace it. Our illustration (Fig. 3) represents the interior of the aluminium factory, which at present contains four reverberatory furnaces in two blocks, each block 23ft. by 8½ft., by 9ft. high. Each furnace is charged from the top with a mixture of cryolite and salt, which when quite melted is drawn off into an iron converter mounted on wheels and trunnions, in which the third and final operation is carried out. We illustrate this operation in Fig. 2, in which is shown the method employed for introducing the sodium into the molten cryolite. Two men, as soon as the sodium is thrown into the fused mass, plunge into it an iron dipper, which is moved up and down until all action ceases. After this "dipping" process, the bulk of the slags are poured off into a large iron pot, while the aluminium is found in the shape of a "button" at the bottom of the converter. The yield of metal amounts to about 8 per cent. of the weight of cryolite, and four parts by weight of sodium are required to furnish one part of aluminium.

For special classes of aluminium the operation is carried on in crucibles, since in this way a better control of the liquid mass of cryolite and flux is obtained, as the crucible stands in the furnace during the whole operation of "dipping." The crucibles are made of fire-clay, and when heated the sodium is introduced by fastening a block of the metal on to an iron rod and covering it with a circular piece of metal provided with holes, and also a slit, into which the rod slides. The circular piece of metal is attached to a rod of iron, which thus acts as a cover to the sodium. By repeating the sodium-dipping a better grade of metal is obtainable. Four qualities of metal are now being made by this process, varying from 90-99 per cent. of aluminium.

A small percentage of aluminium is found distributed through the slag, from which it is recovered in the form of aluminium bronze, by fusion with copper in a reverberatory furnace.—*Industries.*

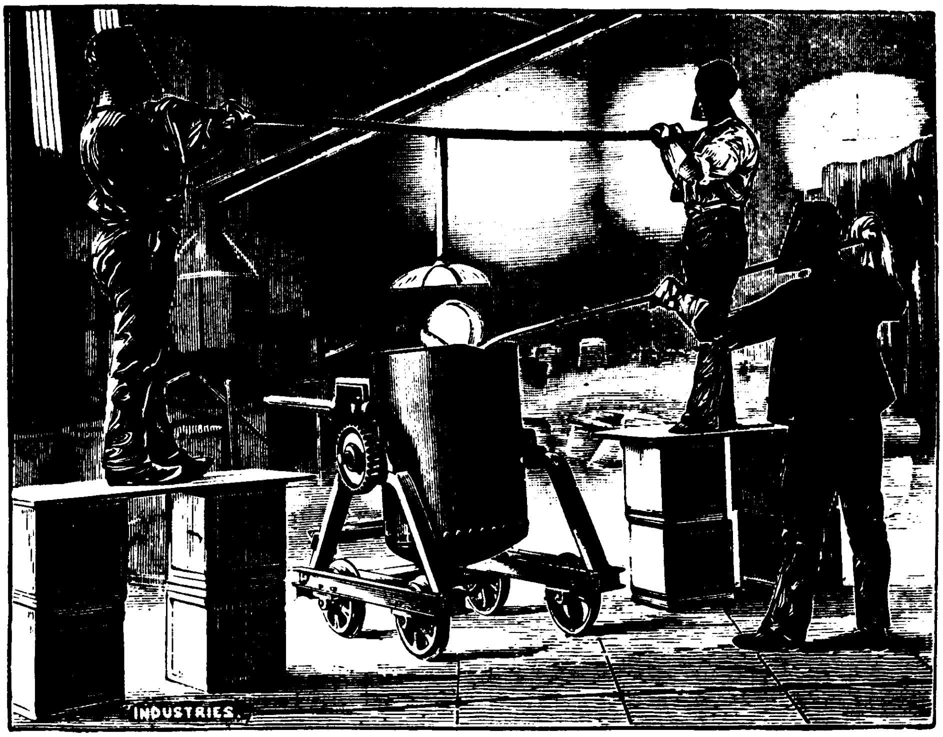


FIG. 2.—INTRODUCING SODIUM INTO MOLTEN CRYOLITE.

FIG. 3.—INTERIOR OF ALUMINIUM FACTORY.

SOME HINTS ON SELECTING A TRADE MARK.

BY COL. F. A. SEELY.

It is almost a daily experience with me to be asked to look at some design, or oftener some word, and to express an opinion of it as a possible trade mark. Sometimes the comparison is instituted between the proposed trade mark and one already known and used for some similar merchandise, and the question takes the form—"In view of that, would this be a good trade mark?" A good-natured person cannot be always refusing to express opinions on questions put to him on the assumption that his opinions are worth having. His natural self-complacency can scarcely resent such inquiries, and I commonly give a curbstone opinion, even when I had much rather not. Sometimes a mere word on the uncertain line which separates fanciful terms from those that are purely descriptive is shown to me, and I am asked to indicate whether it should be treated as a trade mark or as purely label matter. This is not always easy to decide. The nature of the merchandise, the rules of the trade, the particular circumstances of the case, a hundred things of one sort or another, may affect a proper judgment on such questions, and the person to whom they are put, whatever be his experience, may hesitate to answer.

I often mourn over what appears to me the great poverty of imagination among those w adopt trade marks. Certain familiar symbols appear over and over again, and applied to every variety of merchandise. The star, the cross, the anchor, the eagle, are found under various modifications everywhere. Words of a popular character like "Electric" and "Jumbo" are seized upon simultaneously for widely different goods, and there is no end to the persons who lay hold on such semi-descriptive adjectives as "perfect," "superb," "famous," "charming," "standard," "automatic," and the like.

There are a few simple notions on the selection of trade marks which might, perhaps, be called maxims, and the observation of which would save trouble and expense.

A trade mark right is in its nature perpetual. Patents expire with the term for which they are granted. Copyrights have a little longer term, and are renewable ; but they exist only by virtue of statute law, and in the course of years they expire also. But a trade mark has no such limitation. The right it implies is not dependent on any statute, and has no term. Once secured, it goes on with the business, like the poet's brook, forever.

A man starts a small concern, identifying his products by his own trade mark. His sons grow up and are taken into partnership, while the business grows also, and the goods bearing the mark become more widely and favorably known. The style of the firm changes as well as in its personnel ; it expands into a corporation or shrinks into a single individual, but the trade mark associated with the business and its product still belongs to the concern, and as long as the good character of the product is maintained, has a constantly increasing value. This is the history of many a reputable British house, like the great hosiery concern of Morley.

Many modern trade marks are adopted simply to attract trade by their own popular character. Such popularity is often most ephemeral, and the mark, having served its momentary purpose, is dropped for the next sensation. Technically, these are trade marks, while practically the part they perform is less to mark the merchandise as of a particular make than to attract customers by the sentiment they evoke. The persons who use them will not be guided by the maxims of trade mark law in adopting them. To those, however, who propose to adopt trade marks for permanent use in a business which they hope may long continue and outlast the ordinary business life of an individual, I suggest: —

1. Let your trade mark have individuality ; whether it be some pictorial symbol affecting the eye only, or a newly coined word, or some term used arbitrarily and fancifully, let it have a distinct character of its own. The world of fanciful words and designs is boundless. There is never any need of intruding on the ground some other has selected ; and you should select for your trade mark something as far as possible unlike anything used by others on the same class of merchandise. The moment you begin to question in your mind whether you are safe in adopting a six-pointed star for use on your goods, while your neighbor is using already a five-pointed one, it is time to stop. If there is such doubt in your mind, always resolve it against yourself. You may be sure that if the faintest doubt comes to you, it will come to others also, and will becloud your title to that extent. The Irish coachman's rule was a good one ; when asked how near he would drive to the edge of a precipice, while others were vaunting their skill and indicating the inches within which they would dare to approach, he scratched his head and said, "Faith, I'd kape as far off as I cud." I have never seen the rule laid down, but I had it as a fact from a recent Solicitor-General of Great Britain, that in the registry of trade marks the British office always resolves doubts of this kind against the applicant, holding that if the resemblance is so close as even to excite doubt, an honest man ought to select something else not liable to that objection.

It is not always easy to devise an absolutely unique trade mark, but that should be the objective point, and the nearer you can attain to it, the better.

2. A trade mark must be something to which the manufacturer has an exclusive right as a mark for his goods. Not an absolute right, since there can exist no such right to a symbol. But to say that there must exist an exclusive right as against any other person already making or selling similar merchandise is scarcely more than repeating what has been said already. More than this, there must be such a right as will exclude the general public now and in the future. If you are making gum-drops, you may call them *delicious*, may call them so whether they are so or not, but you can have no monopoly in the right to call them so. That is the privilege of every one. Consequently, you cannot take that word for your trade mark ; and this is true of all words that describe merchandise, as adjectives of quality, those which define some quality or characteristic of the merchandise, or which assert its superiority, those which indicate geographically the place of origin, those which indicate ingredients, in short, all words which others may use with equal truth to describe their goods. You cannot shut out the public from any fraction of the right they already possess in the ordinary words of the language. Every man has a right to advertise his merchandise, to describe it, and to extol it as he will. So you cannot adopt as your trade mark that which is merely a picture of your merchandise. Any man may make a clothes wringer or an ore crusher, and use a cut of it in connection with his advertisements. If you have any monopoly in a machine, it is by virtue of a patent ; and when seventeen relentless years have passed, all your right lapses, and you cannot perpetuate it, or narrow the rights of any member of the public who may care to manufacture and sell it, by exclusively holding the right to use a picture of it.

3. Do not multiply your trade marks. One distinctive

mark, well known in connection with your goods, may have great value. A dozen different marks will each tend to destroy the character and value of the other, and are a positive detriment. A trade mark has been neatly defined as "the commercial signature" of the manufacturer. Everybody knows the value of a signature; but everybody knows that if Jay Gould had a new signature for every day in the month, his checks would not pass very freely. Such signatures would authenticate nothing. The case is the same with the multitudinous trade marks fashionable in some branches of industry. Perhaps the conditions of trade make it necessary to constantly vary the brands of soap and cigars, as fashions in bonnets change, but the prudent manufacturer should see to it that each new label bears his distinctive trade mark in addition to the transient brand with which he captivates his customers. If the housewife finds quality guaranteed by the familiar trade mark, she will not object to the fascinating title that charms her cook and laundress.

These are some of the considerations which any one selecting a trade mark for permanent use, and intending to maintain a high character in the business it is to represent, should keep in mind.—*Trade Mark Record.*

MANWAREN'S ELECTRIC METER.

Hitherto the great obstacle to the successful introduction of the electric light to consumers, whose requirements are not sufficient to warrant the expense of a special dynamo and plant, has been the difficulty of arriving at a just and equitable charge for the service rendered. In the use of gas the ordinary meter has worked with satisfaction, but nothing of the kind has thus far been generally brought into use with the electric light. Hitherto this seems to have been impossible, but an invention recently put forward, called "Manwaren's Electric Meter," claims to meet the difficulty. In the *World's Progress* for October we find an illustrated article descriptive of the new claimant, from which the following is taken :—

This meter is designed to serve in the electric lighting what the gas meter does in gas lighting—one indicating the precise amount of gas consumed, the other the precise amount of current utilized. This meter requires no change in the wiring of buildings; no independent wires from each lamp to the meter; no chemical battery to wind the clockworks or operate the register; no change in the sockets for lamps of different candle-power; no delicate scales for weighing the amount of copper deposited; no springs or weights for adjustment. There is also no liability to freezing if located in a cold place. These difficulties, incident to other meters, are obviated in this.

We give a series of illustrations, showing the various features of the device. Fig. 1 is a sectional view showing the relation of the various functional parts. Fig. 2 is a perspective view showing the indicating dials. Fig. 3 shows an under view of the radially disposed armatures. Figs. 4 and 5 are views of the respective sides of the magnet. Fig. 6 is the cylindrical case in which the whole device is contained, the dial face being visible in the glass covered opening near the top. Referring, now, to Fig. 1, A represents a compound or multipolar magnet operating a series of armatures supported by the posts, the inner ends free to move in the vertical slots of the central ring. Referring to Fig. 2, there will be observed a series of threaded posts or cores, which in Fig. 1 will be seen to extend downwardly toward the armatures, and a considerable range of adjustment is afforded by the threaded portion. Suppose the adjustment is made for lamps of 12 candle-power, then the current of one 12 candle-power lamp will raise the first armature, and by adding one more lamp of the same power the second armature is raised, and so on up the capacity of the meter. Thus, if twenty-five lamps of 12 candle-power each be used, all the armatures will be up and in the path of the registering trip or lever. If one lamp of 12 candle-power and one of 24 candle be used, three armatures will rise, and if a 36 candle-power be added, three additional armatures will rise into the orbit of the registering trip, which registers the same as six lamps of 12 candle-power each. It is an important advantage in this meter that allows of lamps of different candle-power to be used at the same time.

At this point it is in order to explain the operative features of the registering mechanism. In the first place, it is primarily effected by clockwork. This clockwork is wound every twenty minutes by the action of the solenoid magnets, which are represented in Figs. 4 and 5. The cores are composed of iron as their front half, and the rear are of non-magnetic metal. The yokes uniting the cores have a rack bar attached (refer now to Fig. 5), and this rack bar engages with gearing that operates the winding post to wind the mainspring. In Fig. 1 the magnet is visible as an end view to show its relation to the clock mechanism. The action of the current forcibly draws the core back into the magnet, and in so doing the rack bar acts on the gearing and winds the spring. When the core has moved in, a stud on the yoke pushes a contact rod (see Fig. 4) away from the contact plates and opens the circuit; the stress of the spring now operates on the clock mechanism, and the rack bar is slowly moved to the length of its travel, when a stud, projecting from the rear end of the yoke, moves the rod into contact with the plates, closing the circuit and causing a prompt back movement to wind the spring as before. This occurs every twenty minutes, and is entirely automatic and reliable.

Having now explained the manner of maintaining an actuating force to drive the clock movement, we will see what is effected by that operation. Referring again to Fig. 1, there will be observed a hollow shaft that is turned by the gearing. At the lower end of this shaft is secured rigidly a horizontal arm, the longer projection of which carries a tread wheel, and the short projection is formed with a downwardly projecting lug into which is pivoted the registering lever. The outer end of this lever has on its upper side an inclined face. The normal position of this lever is horizontal, but when in its course it encounters a raised armature (as it now is doing), the inclined face engaging beneath the projection of the armature depresses the outer end of the lever and raises the inner end. Now, observe a slender stem passing up through the hollow shaft. This stem rests on the short lever, so that every time the outer end is forced down by encountering a raised armature, the slender stem is forced up within the tube or shaft.

We can now refer to the arrangement for working the indicators. A plate is secured to the frame work of the indicating mechanism, and this plate has a free vertical movement by means of a short slot. To this plate are attached two pawls, pull and push, respectively. When the lever below raises the stem and plate, the pawls will act on the ratchet wheel, one in rising and the other in dropping. The plate drops by gravity and normally holds the register lever in position to engage the armatures. The revolution of the ratchet wheel moves a series of reducing gears, so that the train of indexes is relatively moved, the end series extremely slow and capable of a very large record.

It will be understood that the radial series of armatures can

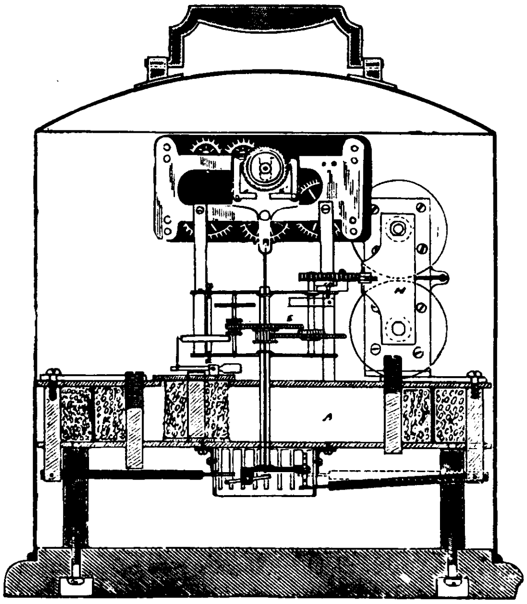


FIG. 1.

be adjusted so that any desired number will respond to the action of the current. The wheel on the end of the arm forces down all the raised armatures in its path, and only those adjusted to the current will rise again to the position to depress the trip lever. Every time the trip lever passes a raised armature the index is moved a point, showing that one lamp has been burning six minutes, that being the time of one rotation of the arm. Suppose, in an establishment, a number of lamps are lighted for varying intervals throughout a dark, cloudy day. Some may be lighted for an hour or two, others may be lighted and extinguished at varying times to correspond to alternate periods of cloudiness and sunshine. It is in just such conditions that the beauties of this meter shine forth. As each lamp is lighted a corresponding armature rises, and in the course of the trip lever arm there will be a corresponding number of movements of the pawl arm moving the indicator, so that the record of the aggregate quantity of current can be very closely approximated.

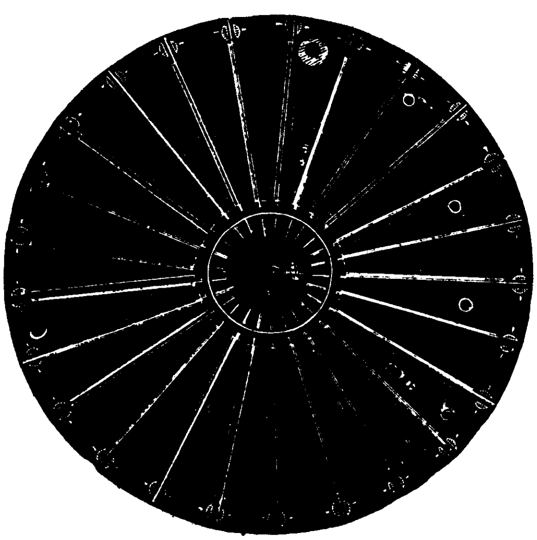


FIG. 3.

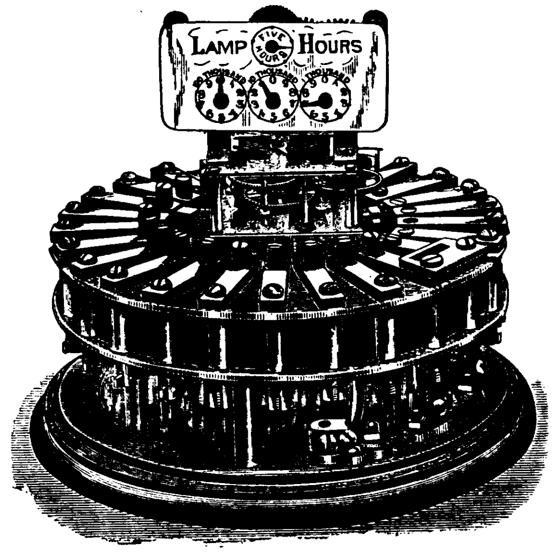


FIG. 2.

A very simple and ingenious arrangement is provided for stopping the clock movement when the current is not on. An armature is pivotally mounted and provided with a vertical stem that normally bears against the periphery of the balance wheel of the clock movement by the gravity of the weighted end. The instant the current is turned on, the armature is deflected, freeing the balance wheel and permitting the movement to proceed. By this arrangement there will be no possibility of the movement running down in the absence of an operating current.

The two coils K and K^1, when connected in multiple arc, double the capacity of the meter, but such a change is rarely required. The cylindrical case being slipped over the meter, hook lugs enter recesses in the plate, and the cylinder is lightly turned, engaging the lugs beneath the plate, and a lock operated by a key secures the engagement. A twenty-five light meter is only 7 × 8 inches in dimensions, weighing complete about ten pounds. A 100 light meter is 12 inches in diameter and 10 inches in height. A 200 light meter is the same diameter and 2 inches higher. Large meters are constructed with several compound magnets, each having a set of armatures and a trip with one magnet placed above the other, and one clock works with the hollow shaft extending entirely through all the different coils used to revolve all the different

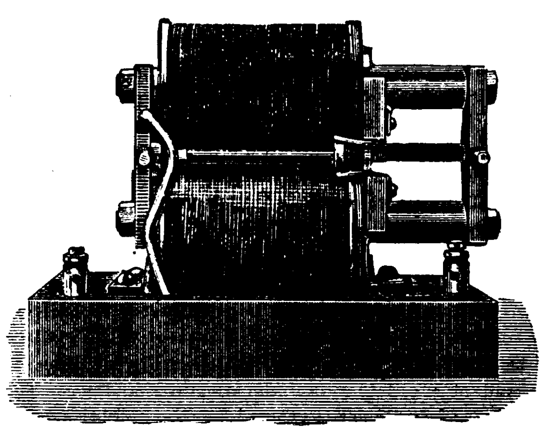


FIG. 4.

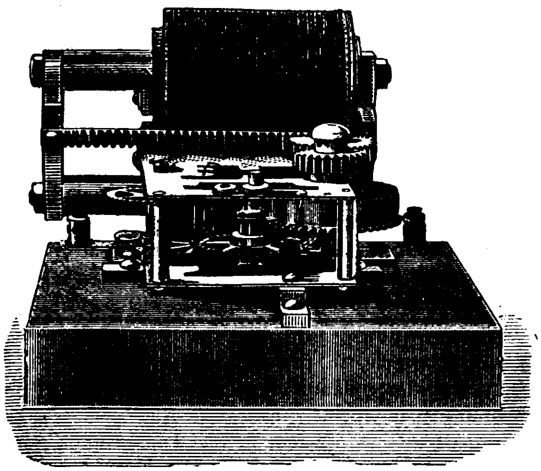


FIG. 5.

trips, which are set in rotation, one in advance of the other, so that only one trip is registering at a time. By this method, a 500 light meter, composed of five 100 light coils placed one above the other, as mentioned, is 12 inches in diameter and 15 inches high, making it compact and convenient for transportation.

There can be no question but that this meter embodies the correct principles, as the operations are practically self-sustaining, automatic, positive and very simple indeed. By the adoption of this meter a most vital problem in electric lighting will be solved, and the business can be carried on an equitable and definite basis, resulting in a vast extension of the lighting system.

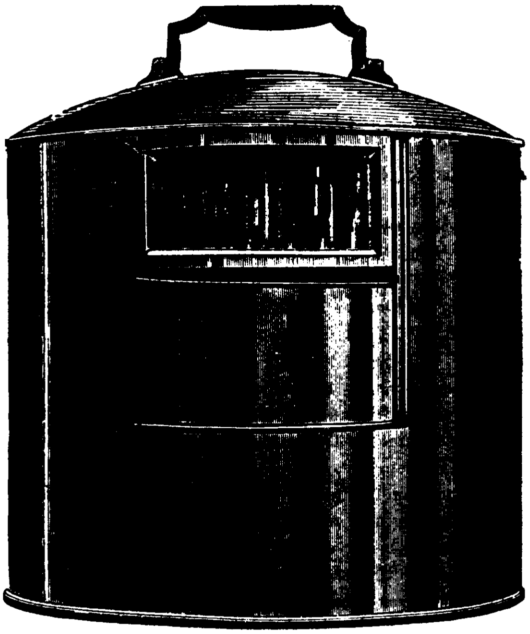


FIG. 6.

SIMPLE MODE OF ASCERTAINING THE REVOLUTIONS OF A SHAFT.

A SIMPLE MODE OF ASCERTAINING THE NUMBER OF REVOLUTIONS OF A REVOLVING SHAFT.

Several rough-and-ready methods of ascertaining the number of revolutions of a shaft are known to engineers, but the following one, suggested by M. C. Me'gs, of W shington, is so simple, ingenious, and, when carefully conducted, so accurate, that we are sure its reproduction here will interest our mechanical readers.

The accompanying engraving illustrates the story so plainly that but few words need be added by way of explanation. A lead pencil is tied fast to the end of the shaft whose revolutions are to be counted, in such a manner that it shall describe a circle of convenient size for observation. If, now, a piece of paper be held lightly against the pencil, the motion of the pencil will describe a circle on it. If, however, the paper be moved forward and backward while the contact with the pencil is maintained, the pencil will describe a series of loops intersecting each other. By timing the period of contact, and then counting the number of loops recorded on the paper, the number of revolutions of the shaft will be given with close approximation to the truth.

DYNAMO ROOM ECONOMY.

BY C. C. HASKINS.

The engineer in charge of the motive power of a large manufacturing establishment holds to a great extent the fortune of his employers in his hand. It lies with him to aid in adding accumulations to the capital invested, or he may disregard the interests of the investors and permit waste and destruction. There are two classes of engineers, and there are two classes of dynamo men, and, while men of the one class are only particularly interested in "quitting time" and pay-day, the second is ever on the alert to accomplish all that can be accomplished in the right direction for the good of all concerned.

The word economy is to the latter employe a word of rich import, of great value, and in the constant practice of that virtue the most successful manufacturers have found the road to wealth and prosperity.

It is not so much what is received or earned, as what is saved of those earnings, which counts in the long run. And it is not alone the larger expenditures which serve to dissipate and fritter away the receipts of any industry. There are numerous smaller expenses which, like the mice in the fable, gnaw many minute holes in the bin, and cause large leaks in the aggregate.

The first and chief factor of importance in the economy of a plant, as all will agree, is the fuel, where the plant is run by steam-power. Assuming that the boilers are of the best, the furnace of the most efficient, the stack a proper one for the purpose, the engineer and dynamo man are both upon trial, from the delivery of the first shovel full of coal under the grate. If the plant is to be run on proper principles of economy not a fire should be built, not a day's run made, without a perfect record being kept of the weight of every shovel of coal and every ounce of refuse left from the burning.

The chemist tells us that we cannot maintain a blazing heat without oxygen, and that this oxygen must come from the air we breathe—that the coal must have sufficient air draft to accomplish perfect combustion of the carbon. The engineer's lieutenant is largely responsible for a very considerable amount of newspaper criticism just now, on account of the waste which darkens the heavens, and gives our atmosphere a decidedly English appearance. The average fireman is not unlike the rest of mankind. He likes to work as little as possible, so he fills the great spaces beneath the boiler to repletion, opens out the draft and goes up to the sidewalk grating, or underneath the coal hole, to rest in the cool breeze and watch the long black cloud which is streaming away toward the horizon from the flag-staff stack of the plant, whence flies the dusky banner.

Think of the waste which is thus set afloat in the air we breathe, to the detriment of health, comfort and laundry, when less fuel at a time, with often repeated charges, would lessen this waste at least 60 to 80 per cent.

But the waste in unconsumed smoke, or, to speak more critically, the permission of this imperfect combustion, has not accomplished all its evil by floating away up and out of the stack. The proportion of ashes and refuse is greater with this method of firing. Then, too, the applied heat is fitful. It rises until there is more steam generated than is needed, and the safety valve comes to the rescue—the doors are thrown open, and huge volumes of heat follow the track of the smoke which a short time before streamed out across the sky like a giant's mourning plume.

There is nothing which conduces to proper economy in an individual equal to an account book. We are all alike in that regard. The engineer and the dynamo man, whether these are represented by one or two persons, are no different from the rest of mankind, and the coal merchant is not widely unlike the rest of us. The economy of weighing the coal will tell two very important and entirely different stories. The per cent of refuse from beneath the grate, when taken from the original weight, will tell the percentage of combustible material in your fuel, and the weighing of the coal will give you a very good idea of how many pounds there are in a ton, down at somebody's coal yard. Mistakes will happen in all well regulated families.

By way of sample, in this connection, let this fact be stated : A fairly large plant with which the writer is acquainted, according to its engineer, uses about 1,900 pounds of coal per diem. Of this 15 per cent in round numbers is waste. Four and one-half pounds of coal per horse-power per hour are used. Is there not a laudable and profitable economy there ?

There may be a very considerable saving in the matter of lubricators. There is economy in pans and strainers and apparatus for keeping the oil where it belongs, using it for legitimate purposes, rather than to allow a large percentage for the saturation of a pile of sawdust, or the floor around the engine or the dynamo.

And there is more than the immediate saving of dollars and cents in the practice of keeping the oil in its proper channel. Fire records show that more than one instance of fire in dynamo and engine rooms has arisen from the careless disposition of oil, or oiled rags, and consequent spontaneous combustion.

Insurance companies are suspicious of electric light plants and electric wires, and are inclined to base high rates of premiums on their fears. It is good economy to show by results that the underwriters are mistaken.

There is a plant whose engineer writes me that he has this "oil question worked down. I am running 14 dynamos. My engine, dynamos, shafting, etc., use an average of one barrel of oil in thirty days. I have no use for oil peddlers."

Dynamo men and electric light men generally, are gradually coming to appreciate the necessity of economy in current. If it is wrong to waste the crude material—the coal—how much worse is it to throw away the manufactured article ?

I have seen a plant which, for want of a very little knowledge on the part of its owners, had depreciated from a 60-light plant to one of hardly half that capacity, and which required a couple of good workmen over a week to put in good working trim again. The dynamo was in poor condition, the commutator sections were badly roughed up, the lamps worked imperfectly, while the lights danced like fire-flies. Carbon dust had accumulated in the bottoms of the lamps, and this interfered with the feeding apparatus. There were numberless joints in the line, the resistance of any one of which was far more than that of any lamp, so that, while the poor machine did its very best in sending out current, the waste in forcing its way over the line was over one-half the output of the machine, and the furnace was a bottomless abyss of expense.

The electric generator is an expensive and in some respects rather delicate machine. It requires but a little neglect or carelessness to ruin a dynamo or a motor. There is a certain amount of wear to it, and there is a dire necessity for keeping it perfectly clean and free from copper dust and dripping oil from overhead shafts and pulleys. If it is imperative that the dynamo should be placed in a position exposed to dropping oil, no time should be lost in protecting it. Oil, pure and simple, is not a good conductor of electricity, but dirt is. Oil gathers dirt, and holds it, and dirty oil becomes a dangerous element under such conditions; besides, a filthy dynamo, or any other machine, is always an assurance of one of three characteristics on the part of the party in charge: carelessness, which is akin to laziness; ignorance, for which there is no excuse; or downright, stubborn incompetency.

The engineer and dynamo man, as well as the fireman and the outside man, should ever bear in mind that there is no royal road to preferment in their calling, but that there is always room to spare upon the upper rounds of the electrical ladder. There is no success without effort. Do you ask what course he shall pursue to arrive at the topmost round? Read: not as he measures the water in the tank or boiler, but as he weighs the coal that goes into the fire. Let him learn to use the instruments which will tell him daily how high his line insulation is, that he may stop a small leak before it either breaks through or endangers the line by increasing the strain at some other weak point. Instruments which will tell him whether his armature or his field is in contact—crossed—with the frame of the dynamo. Instruments that will tell him whether the conducting wire is of proper resistance; or, if it shows a fault, will tell him where the obstruction is, and enable him to remove it, and thus restore his line to its best condition and the lights to their maximum steadiness and brilliancy. All this is in the direct line of economy, and economy in any proper mercantile enterprise is a guarantor of success; its twin at least, if not its synonym.—*Electrical Industries.*

THE ENGINEERING OF WARMING BUILDINGS BY MEANS OF HOT WATER.

For a number of years the Gurney Hot Water Heater Company of Boston, Mass., has conducted a series of very costly experiments in heating buildings by hot water. These have been conducted on such a liberal scale that those interested in the subject as one of applied science, as well as those engaged in the actual erection of heating apparatus, have been alike instructed and profited. The use of hot water for heating purposes is by no means a new thing, but looking at the devices and apparatus, and system in use many years ago, and comparing them with the present adaptations and improvements, there are evidences of wonderful progress and enterprise. Imperfect methods have been corrected; apparatus has been simplified without detraction in efficiency; and artistic designs have been introduced that are creditable to the designers, and appropriate for either places of public resort or private dwellings. Take for a simple instance the heating system of the new Auditorium in Chicago—a marvel of ingenuity, a wonderful display of mechanical skill. With its miles of pipes and elaborate radiators, proving beyond any doubt whatever, that the largest buildings, in even exposed situations, can be comfortably and economically warmed by either steam or hot water. But to return. The results of experiments conducted by the Gurney Hot Water Heater Company have been of a positive and advantageous character, giving a strong impetus to the adoption of hot water as a means of heating buildings, and proving beyond a doubt how the greatest efficiency and economy can be reached with absolute safety and cleanliness. It becomes, therefore, an interesting investigation to examine some of the engineering principles that have been recognized by the Gurney Hot Water Heater Company in the construction of their hot water heaters.

Fig. 1 is a vertical (sectional) representation of the ash-pit, grate, fire-pot and one corrugated section; fig. 2 is a sectional representation, showing general construction, circulation of water, and action of heat on surfaces. Reference being made to fig. 1, we remark that in this heater the initial point of circulation is in the ash-pit, the rays of heat from the bottom of the fire being sufficient to start the water in circulation at this point, which, while it economizes very greatly in fuel, takes up many units of heat which had hitherto been lost by radiation to the cellar. It will be observed that the return water being brought into the water base, is distributed over a larger area than could be done by any other process, the whole base being, properly speaking, a manifold for the reception of the return water of circulation, which being returned at the lowest point of the system, is freed absolutely from any of the repulsion which is inseparable from the introduction of water at a point opposite the heated surfaces of the fire-pot itself. It will thus be seen that in passing very hot surfaces the water does so on vertical lines, and the passage of the water being therefore very rapid, it is not possible to generate steam, and so cause imperfect circulation of the water.

Now, with this fact in mind, it will be noted that the water in the heater, as shown in the accompanying section, is coldest at the base, just above the line of the ash-pit; at this point bricks are introduced, which are dropped into wedge-like chambers, thus presenting a sufficient amount of water surface to the fire, taking away so much heat as may be done without causing the fire to be dull at the outside edge. By the use of this brick as perfect combustion at the edge of the fire as can be done in any stove is secured. Without this brick the heat taken from the fire by the water would be so great as to largely overcome combustion at the outside edges of the fire-pot; this has been the cause in the past of all the slowness that has been complained of in hot water heating. It will be observed in reference to this heater that the grate is made so as to roll on balls, and it is claimed that when loaded to its fullest extent the friction is in a large degree overcome, and by the use of the lever a child may shake the grate of the largest heater made.

We call attention to the fact that perfect combustion cannot be secured in a fire-pot in which water is passing rapidly over the outer surface, carrying away the heat from the outer surface of the fire. To meet this it has always been found necessary to either limit the surface over which the water travels, thus exposing part of the most valuable surface directly to the air of the cellar, or to interpose between the fire and water some kind of partial conductor like fire-brick. We call attention to the very simple method of construction by which is secured the useful effects of this non-conductor without the attendant danger of the efficiency of the fire-pot section being lost through the destruction of the fire-brick. On examination of the illustrations it will be seen that the brick is enclosed in a slot which is wedge-shaped, into which the brick is dropped from the top, and being so placed, is surrounded on three sides by water. By the use of this brick thorough combustion is secured on the outside edges of the fire, which would be impossible without it. The brick is rendered practically indestructible, it not being ever hot enough to fuse with the coal, and being free to move in this slot, expansion and contraction has no effect upon it, so that after four years of firing in the cold climate of Canada, the company

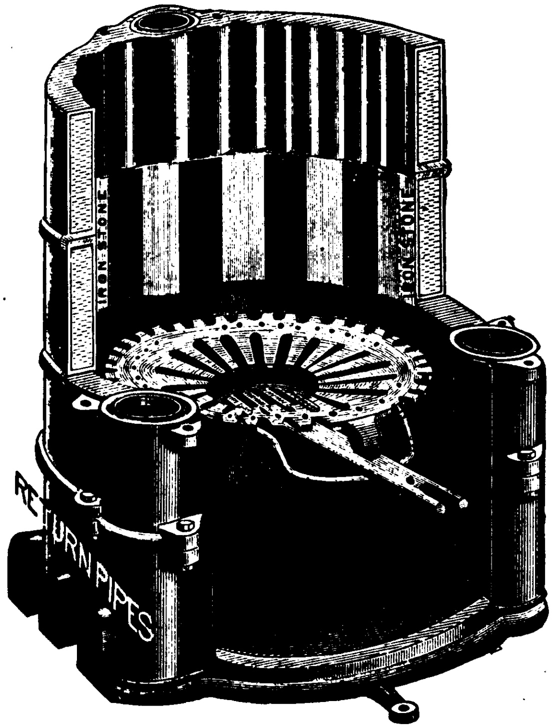


FIG. 1. —WARMING BUILDINGS BY MEANS OF HOT-WATER.

has not yet been called upon to supply a single brick for repairs, although they have put out some thousands of heaters.

It is bad policy in the construction of heating apparatus for dwelling-house use "to swim against the current," and there is no clearer case of this than by building a fire-pot for any kind of heating apparatus which is to be managed by the members of the family or by the servants of a household in any other way than the cylindrical form; square fire-pots for heating apparatus have had their day, and every device, however ingenious, in the way of rocking grates and other methods of mitigating inevitable failure, are but partial remedies, even worse than the disease, for rocking grates in the hands of imperfectly instructed operators are sure to accomplish, sooner or later, two things: First, an inordinate waste of fuel; and second, they burn out, being left a little off the level, the exposed edge is expanded, they become impossible of movement and destruction follows rapidly.

From the excellent engravings given here a clear idea can be immediately formed of the general construction and arrangement of the Gurney Hot Water Heater. From personal examination we can testify to the excellent workmanship and to the high efficiency of this class of heaters.

The peculiar advantages of heating by hot water come under three heads:

1. The radiating surface may be at any temperature desired up to 212°.

2. The volume of the medium for heating (viz., hot water) is larger than in steam.

3. A given volume of water contains more heat than an equal volume of steam.

Let us look at these items in detail: In steam heating the temperatures of the radiators range from 212° to 230°, and unless there is more than one radiator in the room there must be in the room either the maximum amount of heat or none at all given off. In mild weather this necessitates alternately turning on and off the heat, according as the room is too hot or cold. On the other hand the hot water apparatus may have its temperature varied to suit the outside weather, and thus keep the room at a uniform degree of heat by simply regulating the fire.

A cubic foot of steam at 5 or 6 pounds pressure contains about 60 units of heat, about 50 of which are available for heating purposes. A cubic foot of water at 200° temperature has about 10,000 units of heat, of which about 6,500 are available for heating.—*American Engineer.*

POSSIBILITIES OF THE PHONOGRAPH.

Edward Bellamy, the author of "Looking Backward," has just written a fanciful sketch entitled, "With the Eyes Shut," in which he describes an approaching phonographic age. The uses which are found for the phonograph are novel and amusing. Passengers on the railway trains are supplied with phonographic literature so that their eyes are not injured by reading in a jolting coach. The names of the stations are announced by phonograph in clear tones which form a striking contrast to the incomprehensible gibberish of the ordinary brakeman. Mr. Bellamy describes a night's experience in a hotel. He was startled from his dreams by the sound of a voice. He continues: "What had startled me was the voice of a young woman who could not have been standing more than ten feet from my bed. If the tones of her voice were any guide she was not only a young woman but a very charming one. 'My dear sir,' she had said, 'you may possibly be interested in knowing that it now wants just a quarter of three.'" His terror vanished when he discovered that the voice issued from a clock which was equipped with a phonographic announcing apparatus.

FUSED JOINTS.

Frederick J. Smith writes to the London *Electrical Review* as follows: May I be allowed to introduce to your notice a method of making electrical joints by fusion. I was anxious to construct a somewhat complicated network of conductors, in such a manner that the system (as far as possible) be free from Peltier effects. When solder is used we know that such effects exist. In order to avoid this source of trouble I have used joints made by fusing their ends of copper conductors together by means of the oxyhydrogen blowpipe. As many old joints, on which a current has been acting during the usual hours of house lighting, have now been tested and found as strong as when first made, I venture to suggest the method to some of your readers to whom, perhaps, it may be of interest. It is as follows:

A V-groove is cut in a piece of dry fire brick, or a piece of hard quick lime, the ends of the wires to be joined are placed side by side in the groove, and then the flame of the blowpipe is brought down upon them; in the case of a joint made in No. 12 wire, the ends were fused together in 32 seconds. Care must be taken not to prolong the heating after fusion is complete; if the heating is prolonged much after fusion the copper is suddenly converted into minute spheres, which scatter themselves about and leave a thin place where the joint should be. My first joints were made long before oxygen could be bought at its present price; with oxygen as now supplied, joints can be easily and cheaply made in big wires and leads; no flux was used in making any of the joints, nor were the ends cleaned previous to their being heated."

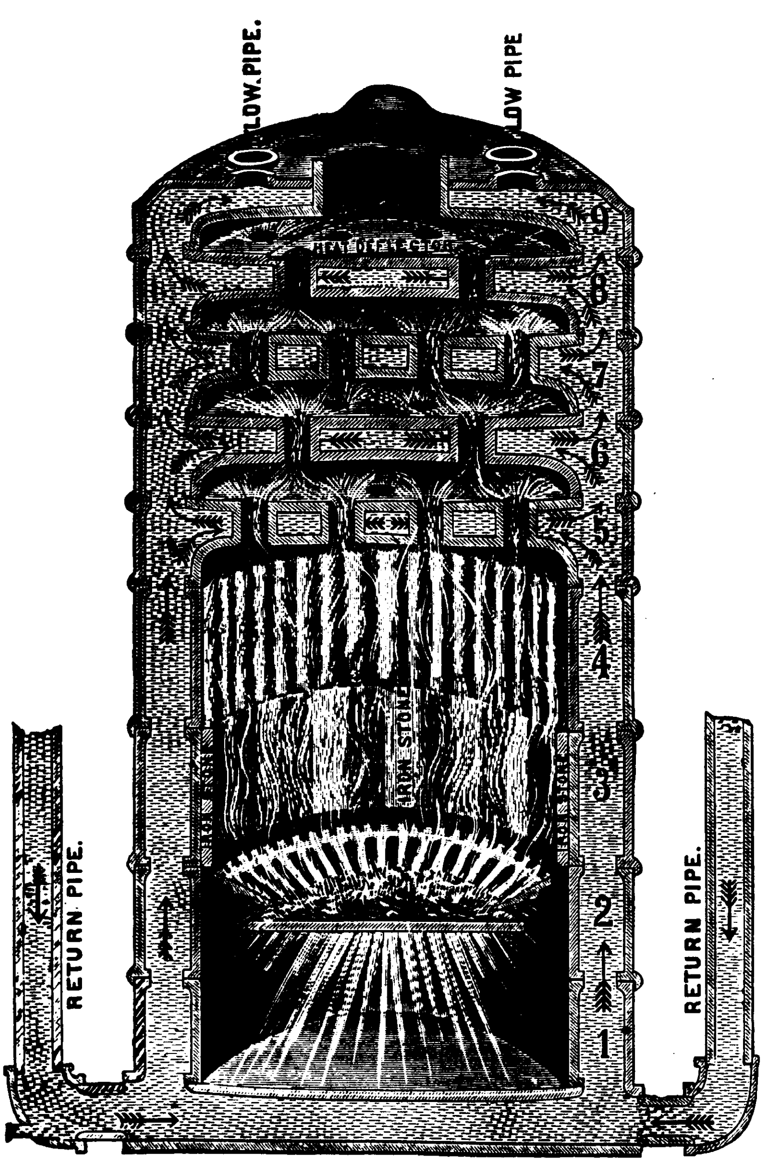


FIG. 2.—WARMING BUILDINGS BY MEANS OF HOT-WATER.

BUILDING CRAFTSMEN AND THEIR WORK.

Amongst the inevitable results of international exhibitions of skilled labour, such as that which closed on Wednesday in the French capital, is the comparison which it invites between the productive skill and workmanship of the countries represented. Before the Great Exhibition of 1851 it was the wont of British manufacturers and art workmen to assume a high rank among the nations; but the result of the great World's Fair was to prove that, in many points, we were inferior in certain qualities of manufacture and skill. In matters of taste or art we were far behind. The English workman has made rapid strides since both in workmanship and design, and in many points or criteria he holds his own against the foreign workman. To be just to him, however, it is necessary to point out in what directions the French artisan and foreigner generally have the advantage—the points of weakness in English training and workmanship. These data, for comparison, have been afforded in the reports drawn up by Metropolitan workmen on the exhibits and results of the Paris Exhibition, of which we gave a *resumé* last week. For many good reasons, we do not think the native artisan the right person to judge of the qualities of work executed abroad—first, because he has natural and national prejudices to overcome; second, because his education and modes of working are very different; third, because a feeling of *esprit de corps* would restrain him from acknowledging a superiority on the part of the foreigner. The outsider or professional artist has no such scruples; his predilections and sympathies are wider. He has no trade secrets to preserve, but is rather inclined—by perhaps self-assertion—to point out errors, and to show how much "better these things are done abroad." We cannot help noticing how this manifestation of trade instinct makes itself felt in reading the descriptions of foreign work; while acknowledging the superiority of the technical education and design, there is evidently a desire to discover defects in the workmanship.

In the first place, a comparison between the building artificers of our country and the Continent is hardly possible. A difference as great as it well can be exists between the modes of living, thought, and feeling of the two countries. House-rent is cheaper than our own. The Paris artisan can live comfortably at a rent of £12 or £15 a year; the firing, charcoal being the fuel, is much cheaper; he obtains his meals at a café when out. Provisions are cheaper than they are here, and the workmen generally frugal and abstemious. Soup, meat, vegetables, and bread are partaken of at breakfast, which is at 11 o'clock, the cost being about 5d.; then, at 6 or 7, after work, they have their dinner, consisting of soup, fish, meat, vegetables, bread, cheese, and wine, the cost of which is about 1s. 3d. The French workman's home is different; it is often at the café, not from choice, but convenience. The children are sent out to nurse, as the wife goes out to work; he sleeps where he can, and does not consider it necessary to keep up a house like his English brother. Wages are paid fortnightly or every three weeks, and piecework is the general principle of payment, and is preferred by both employers and workmen. By this system the workman often earns more than by daywork.

We draw attention now to two or three principles which underlie the difference between French and English workmanship. First, the workman abroad has State protection; the Municipal Council contributes towards the Labour Exchange; trade disputes are settled by a court of experts, the Prud'homme established by the State. The English craftsman has no such aid, but is obliged to have recourse to trade unions, or to the ordinary legal tribunals, which are costly and inefficient. Secondly, the education abroad is technical and complete; the schools have workshops attached, pupils are admitted at 13, and have the run of the school for three years, one of which is spent in the shops, including a smiths' shop, engineers' shop, electrical engineers' shop, carpenters' and wood-turners' shop. The whole course is free, and the cost is defrayed by the Municipal Council. The English workman has nothing of the kind provided, except the new technical schools, which are few comparatively and expensive. Thirdly, the Parisian artisan is free to select his kind of labour; he has a personal interest in his work, which is encouraged by the system of payments, whereas in England the artificer is made a kind of tool in a vast organisation of labour, his work being divided into branches, and he is, therefore, set to do a portion of a fraction of a building which he perhaps never sees and has no interest in whatever. We have proof of these facts in the artisans' reports.

One of the things we hear is that work costs more in France than in England; the men work, we are told, in an "easy-going way." Then, the foreign workingman is his own master in many things; he is not dictated to as to modes of work; he can leave his labour for refreshment when he has a mind to do so, the time so occupied not being deducted if it is not more than a quarter of an hour. The men in Paris are paid almost the same wages for half the work executed. Now, we must not conclude that because the artisan's work is easier, and he takes longer about it, that the cost is greater, except in a very mercenary sense. It is true that, owing to grinding more work out of the workman, he pays the contractor better; but does his labour pay so well in the result? We question whether it does. The unanimous opinion of all who have seen the work of boys in technical schools is that it is a credit to the nation. The whole question of work is resolved into one of *time*, and this is a vital element which the English master does not appear to have fully taken into his consideration. The contract system is in direct opposition; its principle is to get as much work done as possible in a little time, and this has been so ingrafted in the minds of our great producers and employers of labour, that other considerations are sacrificed. The principle with the foreign workman and his employer is to turn out a good job. Even in the school work, time on a job is not considered, so long as the pupil turns out his work creditably.

The important bearing of the question of time, or freedom of individual action on the work actually turned out, may be seen in comparing English with French joinery. Last week we described an internal door as made in France, which is different in several particulars from our own. The stiles and rails are of equal width, about 3 in. wide; instead of the solid English lock rail, a narrow panel is introduced, and upon the upper 3 in. rail of this is the lock. If any reader will take the trouble of drawing out a door to scale, he will find it not so bad as the English joiner would be inclined to think from prejudice and habit. In many respects it is a lighter door, the wide panels of the whole width of door can be left for decoration, the middle rail panel is pleasing if not quite as strong, for every solid lock rail has a double tenon and two mortises. We are so accustomed from habit and years of training to use muntins dividing the door into two panels, that any other form looks wrong; but, after all, it is a matter of design—a quality which the English artificer is not very strong upon. Our system of mouldings is unsatisfactory, but it is used to save time and labour. The machine-made moulding is quickly turned out and planted, but every architect and artistic joiner is aware of the beauty of the moulding worked out of the solid, as seen in Mediæval and 15th-century work in this country.

To "plough" or rebate the moulding for panels, and to groove the back of it to fit on the stiles and rails, is a laborious, but certainly more workmanlike, proceeding than to merely plant the moulding in. It takes more time, and thus, in the eyes of our builders who take contracts, is an objection. Other details, such as rebating the edges of a door to make it fit closer, tonguing the skirting to the floor, stair construction, the jointing of a segmental frame, indicate greater labour, not in every instance necessarily stronger, but displaying more art and skill. To turn to a more artistic trade, the carver in wood is more of a specialist abroad than he is here; a figure carver can obtain a high remuneration for his work by confining himself exclusively to it, and there is enough of one kind of carving to make it answer, whereas in London a carver turns his hand from figures to foliage. In the carving art we have only a few men who can compare favourably with the specialist in Paris, owing to there being so little carving done in London, and what there is of a very miscellaneous kind. We are now alluding to the ordinary class of carvers, not to our few well-known artists in wood. Again, the carvers abroad have exceptional advantages in the fine collections of the Louvre and Tuileries, the Musée de Cluny, and other museums. The work, too, is also done in a more leisurely way than our own—piecework is generally followed, which prevents the cramping influence inseparable from the daywork system, and for the simpler kinds of carving it pays the workman better. On the whole, the Parisian carver is in better circumstances, and his work more appreciated.

In the matter of design, it is fully acknowledged that the English workman is behind is *confrères* abroad. The influence of design on workmanship is to make the workman think before he applies his technical skill; but it is owing to the piecemeal way we carry out work, the putting him behind the contractor, in not recognising his talents, that we have lost our position as designers in the special trades. Till design again assumes its rightful function among our artificers over construction and technical skill, craftsmen must perforce occupy inferior positions in the production of architecture.—*Building News.*

SOME FACTS ABOUT ENGLISH MARINE ENGINEERING.

Every sea-going engineer denounces the extra heat of the high-pressure cylinder end of the engine-room—they do not grumble without reason.

But the difficulties and troubles in the engine-room are insignificant beside those in the fire rooms. To pass between the boilers is to face a temperature positively frightful; it is almost impossible to get a draught of air through this space, but in many ships coal has to be barrowed through it by the trimmers. When forced draught is used the heat in fire rooms rises sometimes in deep ships to as much as 150 deg. The only consideration is to get air to the fires. If this is done it is assumed that the men will be all right. There never was a more unwise policy. It is almost impossible to get furnaces properly worked under such conditions. It is no longer the most skilful fireman who can be employed. It is the strongest man; the man who has the greatest physical powers of endurance. The engineers are often driven to their wits' end to keep the men up to their work. What, it will be said, has high pressure to do with *this*? A great deal. Boilers carrying steam at 160 lbs. radiates more heat than those working at 100 lbs. "The actual difference is but 40 or 50 deg.," it is urged. It is the old story of the straw and the camel's back. Between bad firing and good firing there is much more than 10 per cent, difference, and good firing is next to impossible while "a man can hardly tell the stokehole from the furnace." We are putting on one side the question of humanity; we are considering solely what seems to be the best course to adopt in order to get the utmost possible speed out of a ship, and only those who have tried it, only those who have had actual sea experience will fully appreciate what we have said.

Everyone who is familiar with the matter is agreed that as a rule, the heat in engine and boiler-rooms has augmented with the pressure, and we may add that it does not appear to us that adequate precautions are taken to keep these places cool and well ventilated. It is reasonable to suppose that the best is done that can be done. Further experience is required. It is none the less certain that of two ships equally good in other respects, and equally well manned, that ship will win in an ocean race which has the coolest engine and boiler-rooms. It is all a matter now of a few hours one way or another, and he who wishes to win must not throw away a chance. Bearing in mind the extra risks incurred and the extra trouble involved, and the additional tax on the endurance of firemen and engineers, we repeat that we are by no means certain that triple expansion engines working at 160 lb. are as good for Atlantic racing as three-cylinder compound engines, working at 90 lb. or 100 lb. pressure, and the success of the Etruria goes a long way to support our opinions.—*American Engineer.*

SEEING TO A DISTANCE BY ELECTRICITY.

A correspondent to *La Lumière Electrique* thus comments upon M. L. Weiller's paper which appears in *Le Génie Civil*, vol. xv., p. 570:—

The writer endeavours to solve the important question of vision to a distance by electricity by means of a combination consisting of selenium cell, a gas telephone and revolving mirrors, forming a special apparatus which he designates a phoroscope, and which we will briefly discuss.

The question of vision to a distance by electricity is governed by the two following fundamental principles. In order to get the impression of the form, outlines or details of one or several objects, it is not necessary—1. That the eye should receive all the rays proceeding from it. 2. That it should receive, at the same time, the luminous rays necessary for vision.

Some very simple examples will demonstrate the first principle. We can see an object very clearly through wire gauze, and the image is perfect if the interstices are large and the wire fine. Carpets and mosaic seen at a certain distance do not seem to be formed of a number of parallel lines, or by the juxtaposition of little stones. An engraving, a picture, and especially a chromo-lithograph, show at a distance no discontinuity in the work, although the engraving is composed of lines and the chromo-lithograph of separate little dots.

We see thus that it is possible to have a sufficiently clear perception of an object by the vision of a system of more or less luminous lines forming a kind of pattern.

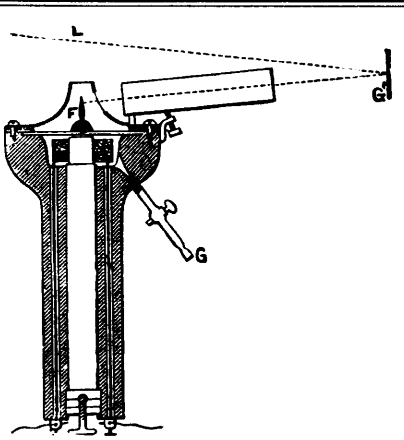
The second principle is quite as well-known and as deduced, from the duration of the luminous impressions upon the retina a period of about $\frac{1}{10}$th of a second.

A series of impressions succeeding one another in a very short time produces the effect of simultaneous impressions, and it follows that in order to perceive the image which we have called the pattern, it is sufficient to receive the luminous impressions of the different lines that constitute it in an interval of less time than $\frac{1}{10}$th of a second.

It was by taking this principle as a basis that Lissajous studied from an optical point of view the vibratory movements of bodies. His experiments are so well known that we need not enter into them here. Lissajous' curves are produced in a retangular portion of a picture. If, on the other hand, this object possesses the power of lighting, all the rays proceeding from the space occupied by the curve will, in an excessively short space of time, converge at one point after having been subjected to a double reflection on the mirrors of the two tuning forks that were employed for this experiment.

We may substitute for these forks any movable system whatever, bearing a series of mirrors arranged in such a manner that the displacement of each of them brings upon the same straight line all the rays projected from a portion of an illuminated object. Let us suppose the mirrors to be placed on a circle turning upon an axis perpendicular to its plane, and each of them making a different angle near 90° with this plane. To each mirror there will be a corresponding series of parallel lines in the picture, and if the rotation is sufficiently rapid all the rays proceeding from the object represented in the picture will meet at the same time, in as short an interval of time as required. It is thus possible to bring to one point all the luminous rays proceeding from a pattern, and each portion of the image thus producing its impression upon the retina in succession, it is sufficient that the interval in which these impressions succeed one another, should be sufficiently short for them to be rendered simultaneous.

The transformation of the luminous waves into electric cur-

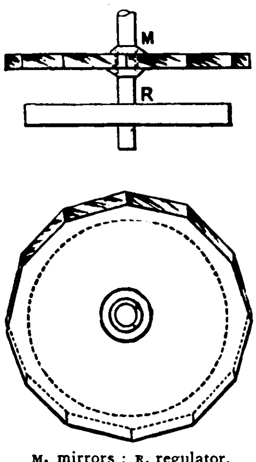


L, lunette; F, flame; G, gas; G^1, glass.

FIG. 1.

rents is performed by means of a radiophonic receiver forming part of an electric circuit. This receiver may be a cell of selenium lamp-black, hydrogenated palladium, &c., the resistance of which varies with the quantity of light received. The different portions of the pattern will act differently according to the quantity of light emanating from them and in an interval of time less than $\frac{1}{10}$th of a second: the variations of resistance of the circuit will correspond to the image observed.

In order to solve the opposite problem, *i. e.*, to extract this image from the circuit at the receiving station, the writer proposes to employ the gas telephone, which is an instrument of extreme sensitiveness. It consists of an ordinary telephone (fig 1) in which the portion comprised between the plate, the

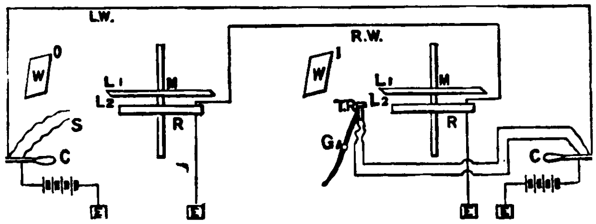


M, mirrors; R, regulator.
30 revolutions per second; 300 glasses on the side instead of 12.

FIG. 2.

bobbin, and the inner sides is in communication with a gas pipe; the vibrating membrane is pierced in the centre with a little hole, through which escapes the gas which is lighted; this little flame will undergo a variation in brilliancy at each movement of the membrane, and it will produce a continuous succession of rays similar to those arriving upon the radiophonic receiver. In order to show them and form an image similar to the pattern, a system of mirrors is employed (fig. 2) similar to that used at the first station, but acting in the reverse way. It is evident that these two apparatus must act synchronically like the Hughes and Baudot regulators employed in telegraphy.

Station 2 will reproduce upon a sheet the lines taken upon the image at Station 1.



L.W, line wire; R.W., regulator wire; L^1 L^2 lenses; M, mirror apparatus; R, regulators: O, object; I, image; S, selenium transmitter: C, commutators; G, gas; T.R, telephone receiver; E, earth.

FIG. 3.

The writer gives the name of phoroscope to an apparatus of this description, the different parts which we have described being combined according to the plan shown in fig. 3. The image that we wish to transmit is broken up into a series of parallel lines, the different points of which act in succession upon a selinium cell making the intensity of the current connecting the two stations vary. These variations in electrical intensity are transformed by the gas telephone into variations of luminous intensity, and the successive changes of brilliancy of the little flame are projected upon a sheet at points corresponding to the various points of this sheet.

Theoretically, nothing can prevent this double transformation of luminous intensity into electric intensity, but the realization of the experiment is surrounded with difficulties which make us fear that it will be long before a practical phoroscope is produced, but this should not discourage enterprising and persevering physicists.

HEAT.

Heat is the manifestation of an extremely rapid vibratory motion of the molecules of a body. An increase in the velocity and amplitude of the vibrations increases the temperature of the body. A heated mass can impart vibratory motion to the ether which fills space and permeates all bodies, and these wave motions of the ether are able to reproduce in bodies motions similar to those by which they were caused.

The more obvious effects of heat are expansion, fusion, and vaporization. All bodies increase in volume when heated, gases being the most expansible, liquids next, and solids the

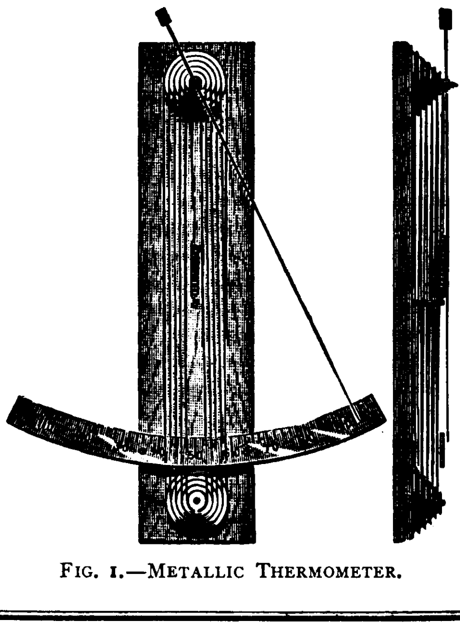


FIG. 1.—METALLIC THERMOMETER.

least. Heat may partially or wholly balance molecular attraction. Hence it is that, when heated, solids first expand, then (if no chemical action occurs) soften and become liquid, and finally vaporize. Liquids are changed into vapors, and gases are rarefied.

EXPANSION.

Expansion takes place in all directions. To render this phenomenon apparent, an elongated and attenuated body, such, for example, as a fine wire, is chosen and its linear expansion only is noted. Fig. 1 shows an instrument for exhibiting the linear expansion of a long thin wire, 1 and 2 being respectively front and side views. The instrument is provided with two series of hard rubber pulleys mounted on studs projecting from a board. A fine brass wire (No. 32) attached to the board at one end passes around the successive pulleys of the upper and lower series in alternation, the last end being connected with one end of a spiral spring, which is strong enough to keep the wire taut without stretching it. The

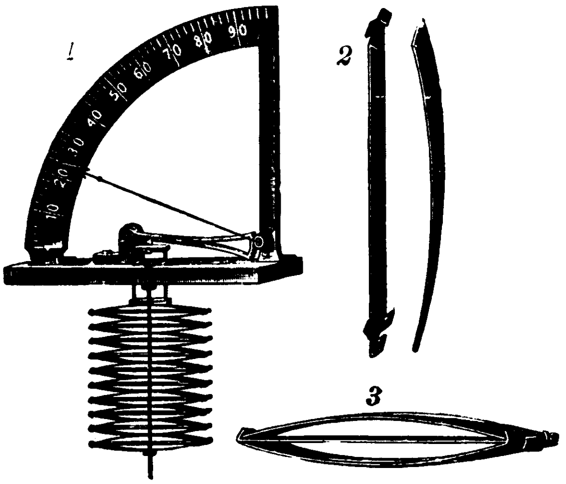


FIG. 2.—THERMOSTAT.

other end of the spring is attached to a stud projecting from the board. The pulleys are of different diameters, so that each series forms a cone. By this construction the wire of one convolution is prevented from covering the wire of the next.

The last pulley of the upper series is provided with a boss, to which is attached a counter balanced index. A curved scale is supported behind the index by posts projecting from the board.

The series of pulleys are 12 inches apart, and there are ten convolutions of wire, so that a small change of temperature produces sufficient expansion of the wire to cause a perceptible movement of the index. To increase the sensitiveness of the instrument, the wire is blackened by means of smoke or dead black varnish. An electric current passing through the wire heats it sufficiently to cause a deflection of the index, the amount of deflection depending, of course, upon the strength of the current.

Fig. 2 shows a simple thermostat which is capable of many useful applications. It is representod with an index and scale, but these are not essential for most purposes.

The instrument depends for its operation on the difference between the expansion of brass and steel. The linear expansion of brass is nearly double that of steel, so that when a curved bar of brass is confined at the ends by a straight bar of steel, the brass bar will elongate more than the steel bar when both are heated, and will in consequence become more convex.

At 2 are shown two bars, the straight one being of steel, the curved one of brass. The steel bar is slit for a short distance in two places at each end, and the ears thus formed are bent in opposite directions to form abutment for the ends of the curved brass bars, two brass bars being held by a single steel bar, thus forming a compound bar, as shown at 3. Each compound bar is drilled through at the center. Ten or more such compound bars are strung together loosely upon a rod, which is secured to a fixed support. A stirrup formed of two rods and two cross pieces rests upon the upper compound bar and passes upward through the support. Above the support it is connected by a link with a sector lever which engages a pinion on the pivot of the index. The use to which the thermostat is to be applied will determine its size and construction. It may be used in connection with kilns and ovens and for operating dampers, valves and electric switches.

THE NEAR FUTURE OF ELECTRICITY.

BY GEORGE CUTTER.

We, who are unfortunate enough to have less than half of our probable time of life to look ahead to, are greatly pleased with the rapidity of electrical development, as it assures us the probability of seeing many of the wonderful advances to be made in the growth of the science, pure and applied. But we realize that the inventions and discoveries of the near future are likely to be closely allied to the accomplishments of the present. The development of new fields is to be left to succeeding generations. We can hardly hope to see the successful production of electricity in large quantities for commercial use, direct from crude material instead of the present expensive method of passing our energy through the boiler and steam engine. The full understanding of the production of light by the fire-fly and the applications in that direction are certainly too far ahead to afford us a ray of hope of anything more than an imaginary picture of what will be done.

We may imagine that our cities will be lit by some luminous compounds on the walls which will give out the light at night that absorbed in the day time, but in this we are letting our imaginations loose and getting so far away from the practical work of the present, that the time so spent must be charged to recreation and pleasure account. Whereas the time spent in forming mental pictures of the widest possible developments in directions at present pursued may prove very valuable. Our best inventions and discoveries are made by such use of the imagination.

The superiority of the electric light over all others is well understood, and the great problem is to furnish it to all without stint or preference. The immediate demand in our large cities is for installations of hundreds of thousands horse-power instead of those of a few thousand horse-power merely. As Americans it does not behoove us to ask the authorities to pass laws which will limit our work to that particular system that we have partially developed. The expression "We can't" should not exist in the American electrician's vocabulary, as it should always be supplanted by the question "How can we?"

If all sorts of wires are run in all sorts of ways, except the correct ones, about the city of New York, and then an overzealous authority takes steps that prevent the different lighting companies from keeping the heterogeneous mixture of wires in half-way decent working order results in the death of several employes in quick succession, we do not need to assume at once that certain systems CANNOT be safely distributed. A careful, candid study of the situation to trace the cause of the accidents with a view to remedy the evil is much more to our credit. The very small number of such accidents in the whole world during the existence of these necessarily fatal systems certainly indicates that the problem is comparatively simple. By using high class insulating wires such as are already largely in use, and by planning circuits so as to prevent such a snarl as now exists in New York, the danger can be almost entirely removed. Some accidents are bound to happen just the same as in other industries in our crowded cities.

Because 15 people "perished in absent-mindedly blowing out the gas" in the city of Chicago in the year 1888, we do not strive to pass a law preventing the use of this dangerous mixture. Fortunately the scarecrow articles of a few interested individuals cannot block our industries in this country, and we may, therefore, look forward to the establishment in the near future of large installations for the distribution of energy by electricity. Why should we not have an installation in Chicago of 2,000,000 or 3,000,000 lamps instead of 30,000 or 40,000? It is sure to come. The electric light is needed in all the offices, stores, residences, etc., in the city, and they are going to have it. We need not hope to get it by a system that would necessitate an expensive station every half mile; therefore, we must look for some means of distributing at great distances. This necessitates high pressures in the distributing wires, and some means of conversion which will reduce this pressure for the inside wires. The conversion by accumulators is being developed persistently, and it is hoped successfully, because they add to the property of changing the pressure the other great advantage of storing the energy until wanted.

The conversion of high pressure continuous currents to low pressure currents by means of "direct current" or "dynamo converters" is also being developed, and let us hope that the "wizard" of Menlo park will succeed to fulfil his promises in this direction, so that we may have a great variety of methods for accomplishing this much-desired result. Thus far the success has been achieved by alternating currents, and they certainly promise well for the future. The ease and flexibility, so to speak, of changing the phases of the current in alternating currents attract the inventive genius of the industry at the present time.

But the dynamos for the large installations of the future are yet to be developed. They are not to be small machines of merely 1,000, 2,000 or 3,000 lamps, but they are to be of 50,000, 100,000 or even 200,000 lamps. The "armatures," so called, are to be built up in sections, with ready means of connecting together, and with safety appliances to prevent one bad section interfering with the lighting circuits. The field magnets, being free from trouble, are to be revolved and also divided into sections, so that the electricity can be cut out of one section without interfering with the other, the whole machine to be about like a long cylinder revolving inside a thin shell of armature coils. The whole steam plant is to be the perfection of steam engineering, studied to save labor and fuel, and to be thoroughly reliable.

Practically all the lighting in the large cities is to be done by electricity, and immense installations are to be common occurrences.

All places using small powers will adopt the electric motor. The great saving arising by distributing these small powers from power centres is already appreciated.

Another great use of electricity is just commanding attention, and that is the distribution of parcels. Instead of blocking the streets with parcel delivery waggons of the different firms, these parcels will all be distributed by electric carriers. The cities will save great sums in street and paving departments, and the individual firms will get their parcels distributed much more cheaply and more satisfactorily.

Possibly this scheme may meet the support of the philanthropic natures, who are advocating laws which will exclude dangerous electric currents because of a few deaths they have learned of. As more people were killed by teams in the streets of New York and Brooklyn in the last two years than have been killed by electric currents in the whole history of the world, any system which will reduce the number of the "fatal parcel carriers" to a minimum will appeal to their great love of human life for support. When the electric parcel carriers are established, perhaps a law can be passed which will prevent any firm from driving parcel delivery teams about the streets and thereby killing an average of over one person per week in New York, instead of using the harmless parcel carriers worked by electricity.

The transmission of power by electricity in mining regions is to be extensively applied in the next few years. Mines that cannot be worked at present will be made very profitable by using electric motors worked from distant sources. This line of work is especially attractive, because the great benefit arising warrants a large outlay of capital to accomplish it; so the electrical engineer will have the satisfaction of being able to make everything first-class, without regard to cost.—*Electrical Industries.*

THE BEST FORM OF MOTOR.

The introduction of motors for power transmission will soon be governed by their cost. The questions of reliability, safety and convenience are all important, but dollars and cents are the most conspicuous considerations, and this point is by no means overlooked by the manufacturers of motors.

The evolution of a perfect machine of this character is necessarily a slow process. Its original design and construction is in the hands of the inventor and a few practical mechanics. When it is placed in actual service, the modifications begin. It is strengthened in one part and lightened in another. Its construction gradually simplified. The arrangement of the parts is changed in order to facilitate examination and possible adjustment. Nothing but the lapse of time and the exigencies of actual service will develop all the faults and suggest all the improvements which may be made. When practical perfection is eventually attained, special machinery may be devised, which will bring the cost of production down to the lowest point, greatly enlarging the sales, even if the profit on each motor is reduced. This is the natural course through which any line of manufacturing must pass in order to attain the highest degree of perfection.

So long as competition tends toward the production of a better article at less money, it is beneficial, provided it is done at a reasonable profit; when, however, an effort is made to reduce cost by introducing an insufficient quantity of material, or that of an inferior quality, the result is more likely to show loss rather than gain. The high speed at which dynamos and motors are run, and their suspectibility to damage if not properly balanced and fitted, has led up to first class workmanship. Therefore, it seems reasonable to suppose that in this particular branch of the electrical business there is little apprehension of retrogression.—*Electric Power.*

MEASUREMENT OF ELECTRICAL APPARATUS.

The observant reader of our electrical literature cannot fail to notice the unmethodical style in which the proportions of machines, wires, etc., are expressed by many of our best writers, while the careful student is annoyed and his time wasted by the constant necessity for translating feet and inches into the metric system and *vice versa.*

The weight of a dynamo is given in pounds, tons or kilogrammes, while its output is expressed in "units," horse-powers, electrical horse-powers, watts, kilowatts or volts and amperes separately numbered.

We have the dimensions of the bed-plate of a dynamo in feet, those of its armature and magnet cores in inches, while the area of its pole-pieces is reckoned in square centimeters; the length of its field coils is so many yards, meters or feet, while the cross-section of this wire and of the armature windings is given in a small fraction of a square inch, in mils and occasionally in square millimeters; and then the thickness of the armature laminæ is written in hundredths of an inch.

The sizes of wires are indicated by the arbitrary numbers of the makers; in thousandths or hundredths of an inch; in mils and millimeters; in diameters of "nearly three-tenths of an inch," "about five-sixteenths of an inch," approximately one-eight inches," etc., etc., etc.

Why should this heterogeneous style of measurement be longer tolerated? Electro technics has a clear, consistent and logical nomenclature of its own, the exclusive use of which would greatly simplify computations and the solution of all problems involving the measurement of electrical apparatus and would facilitate the writing, printing and reading of descriptions of machines, records of tests, experiments, etc.

It has been said that the meter, centimeter and millimeter with their symbols, m., cm. and mm., do not convey to English readers such definite ideas as yards, feet and inches. If this be true, it is also true that such readers can have no clear conception of the most usual electrical units, since these are based upon the metric system, an elementary knowledge of which is indispensable to their understanding of these units.

The English unit of length is said to have been based upon the length of the arm of a king who centuries since returned to the dust whence he came. The unit, the yard, was arbitrarily divided into certain portions having no natural relation to it or to each other, and this smallest portion has again been divided into mils, which are absurdly small, too small to be of much practical use. They cannot be seen by the naked eye and are, therefore, mere abstractions to the ordinary workman who frequently needs to know the relation which should subsist between units of current and the cross-sections of conductors.

The square millimeter is small enough for all theoretical as well as practical purposes. Is not the idea of three amperes to the square millimeter more easily grasped than that of 520 mils to the ampere? In the first case we have a small number of amperes flowing through a small, but readily seen, unit of area, while the second requires us to conceive the passage of one ampere through a large number of invisible and impractical mils. Moreover, the meter is based upon a painstaking survey of an arc of the meridian, planned and executed by a body of competent scientific men. The decimal divisions of this unit render the computation of problems expressed in them ideally easy and the nomenclature of the metric system carries its meaning with it.

As the second is the unit of time in most electrical computations, why should not the revolutions of armatures be expressed as so many per second instead of 60 times that number? And the use of the centigrade degree is estimating the rise of temperature in dynamos, would be entitled to a place in the system of measurement which is here advocated.

It would, perhaps, be too much to expect the wire makers to reconstruct their guages in conformity with the metric system, but that would follow as a natural consequence of the consistent use by electrical engineers, dynamo and motor builders of the clear and systematic electrical nomenclature we already possess. This would not only facilitate all our own work and study, but would give to our writing a value in the eyes of continental readers which it cannot now have, since they could scarcely be blamed if they concluded that our electrical "manners and customs" and the results attained thereby, were as slipshod, haphazard and generally untoward as our style of expressing them too often is.—HOWARD PEACOCK, *in The Electrical Engineer.*

AN OPTICAL ILLUSION.

We are going to present to our readers the solution of a problem that came in our way by accident during our peregrinations in search of curiosities of all kinds, and which consists in making a few persons appear like an innumerable crowd. This interesting scientific recreation was exhibited some time ago in a public establishment near the universal exposition. It is now no longer in existence, but doubtless we shall soon have an opportunity of seeing it again at our fete day shows.

The realization of this optical illusion, however, is one of the simplest of matters, and requires the use of but very elementary material.

Let us imagine that three perfectly plain and very clear mirror glasses, as large as possible, form a prism whose base is an equilateral triangle. A person placed in the interior of this prism will see his image reflected a very large number of times. A very simple geometrical construction, and one which we recommend our young readers to carry out as an exercise in optics, by the simple application of the principle that the angle of incidence is equal to the angle of reflection, allows us to see that the image of any point whatever placed in the centre of this triangle of glass plates will be reproduced indefinitely by groups of six images distributed symmetrically around points regularly spaced in the prolongations of the planes of the three glasses.

A person, therefore, sees his image reproduced indefinitely in groupes of six until, the successive reflections attenuating the intensity of the images, the latter cease to be visible. Three or four persons massed in one of the angles present the illusion of a compact and mixed crowd standing upon the side-walk and awaiting the passage of a procession. The hats waving in the air convert the peaceful waiting into an enthusiastic manifestation, which is so more the surprising in that it is made by but half a dozen persons at the maximum.

The accompanying figure gives an idea of this remarkable effect, and the three persons, whose images reflected *ad infinitum* produce the curious result that we call attention to, would have much trouble to believe that they were the subject of an illusion.

Upon the whole, the experiment is nothing more than an application of the principle of the old kaleidoscope enlarged and revived, in the sense that the observer has before his eyes the successive reflections of his own image, and that the

An Optical Illusion Produced with Three Mirrors.

objects are replaced with living beings movable at will.

Five or six persons may occupy, at the same time, the triangular prism, of which the sides are about six feet wide, and which they enter through a trap in the floor. When these five or six persons are walking about in all directions, they present the aspect of a tumultuous and agitated crowd commenting upon grave events.—*La Nature.*

MODIFIED WIMSHURST MACHINE.*

The Wimshurst electrical machine is the most recent and on some accounts it is the best that has been devised. It is less affected by atmospheric conditions, and may be relied on in all weathers for results of some kind, while the frictional machines and the induction machines of Holtz and Toepler generally fail in a damp atmosphere.

The Wimshurst machine here shown differs from the ordinary type, mainly in having the rotary disks inclosed by a hoop and glass cover disks to exclude dust and moisture, the stationary disks being provided with brushes which are connected electrically by strips of tin foil secured to the inner faces of the outer disks by means of shellac.

This machine is shown in perspective in Fig. 1. Fig. 2 is a vertical section taken through the centre of the disks, and Fig. 3 is an enlarged horizontal section taken on the line of the collectors.

The column supporting the revolving disks is provided with a hollow arm in which is journaled a tubular shaft, upon one end of which is mounted a disk of common window glass between two collars, the glass being centrally apertured to receive the shaft, the outer collar being screwed on.

* From "Experimental Science," by George M. Hopkins. Munn & Co., publishers, New York.

The opposite end of the tubular shaft is provided with a grooved pulley. A solid shaft placed within the tubular shaft, and projecting beyond the ends thereof, carries upon one end a glass disk, and upon the other a grooved pulley, as in the first case. The glass disks are separated from each other about ⅛ inch. They are both coated with shellac varnish and allowed to dry. To each glass disk near its periphery are secured 16 radial sector plates of tin foil or thin brass, arranged at equal angular distances apart. These sec-

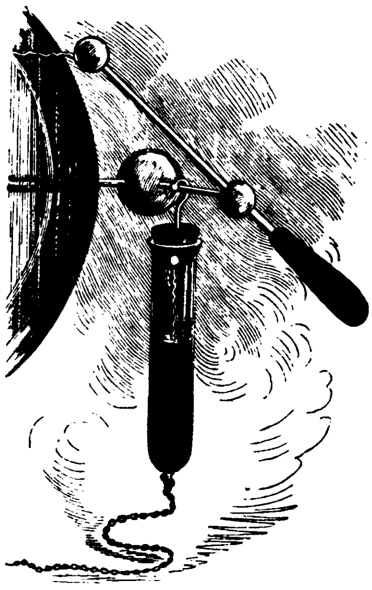


Fig. 4.—Attachment of the Leyden Jar.

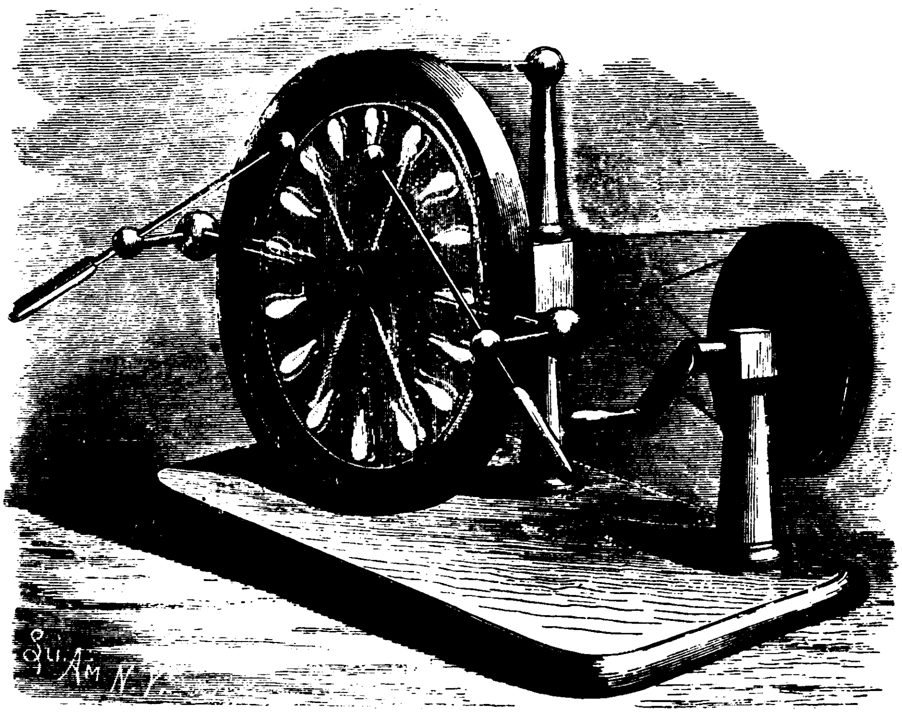


FIG. 1.—MODIFIED WIMSHURST INDUCTION MACHINES.

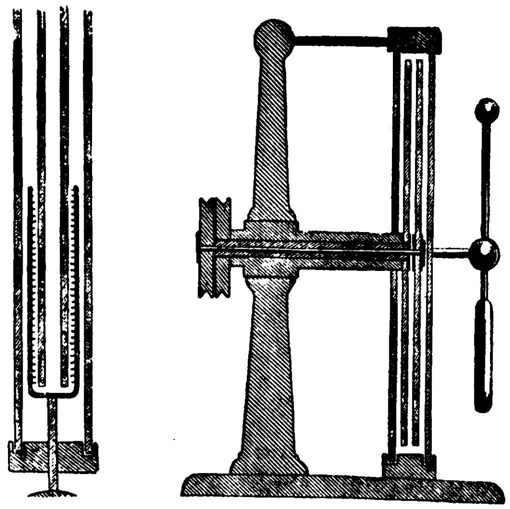


FIG. 3. FIG. 2.

SECTIONAL VIEWS OF MODIFIED WIMSHURST MACHINE.

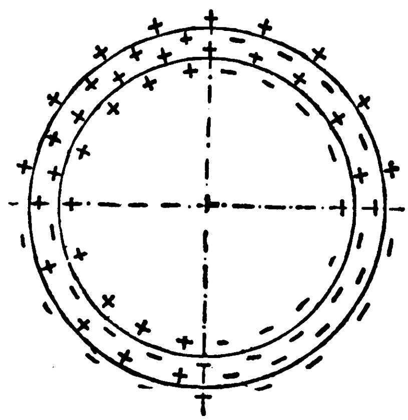


FIG. 5.—DISTRIBUTION OF ELECTRICITY UPON THE PLATES.

tors are coated on one side with shellac varnish and allowed to dry, when they are placed in position on the varnished glass disks, varnished side down, and secured by rubbing each one quickly with a warm, smooth iron.

A drawing should be made of a glass disk with the sectors to be placed under the disks as a guide in locating the sectors. Brass sectors are preferable on account of their superior wearing qualities.

The glass disks are placed on their respective shafts with the sectors outward. A ring of vulcanite surrounds the glass disks and is grooved internally to receive the stationary glass disks, which inclose the rotary ones. The vulcanite ring is divided at the top and bottom to allow of applying it to the stationary plates. The rear plate is centrally apertured to admit the tubular support of the shafts. The vulcanite ring is provided, at the top and bottom, where it is divided, with vulcanite dowels, and is supported by attachment at the bottom to the base board, and at the top to a wooden rod projecting from the upper end of the column.

In diametrically opposite sides of the vulcanite ring, and on a level with the axis of the disks, are inserted brass rods, provided on their inner ends with metallic forks, the arms of which extend along the outer surfaces of the rotary disks and are provided with collecting points, as shown in Fig. 3. The outer ends of the brass rods are furnished with knobs, into which are inserted the supports of the discharge rods or conductors. The latter are provided with vulcanite handles, by which they may be moved in these supports as may be required.

The stationary glass disks are each provided on their inner faces at diametrically opposite points with small metallic sockets, attached to the glass with cement, and containing brushes of tinsel or very fine brass wire, which touch the rotary disks lightly. The brushes of each pair are connected by a narrow strip of tin foil attached to the glass. The stationary glass disks may be turned in the vulcanite ring to adjust the brushes at the required angle, which is about 45° with the plane of the collecting forks.

One of the rotary disks is driven by a straight belt, the other by a crossed belt, both belts being carried by a doubly grooved wheel fixed to a shaft journaled in a standard attached to the base. This shaft is furnished with a crank, by which it is turned.

To secure good results, small Leyden jars or condensers must be connected with the conductors, as shown in Fig. 4. To the bottom of each jar is attached a small chain. These chains are brought into contact when a detonating discharge is desired, and separated for a silent discharge.

The machine is self-exciting, and yields sparks varying in length from one-fourth to nearly one-half of the radius of the rotary disks, according to the state of the atmosphere and the condition of the machine.

The machine illustrated has 12 inch rotary disks and 14 inch stationary disks.

Mr. Wimshurst has constructed the diagram (Fig. 5) which shows the distribution of the electricity upon the plate surfaces when the machine is fully excited. The inner circle of signs corresponds with the electricity upon the front surface of the disk. The two circles of signs between the two black rings refer to the electricity between the disks, while the outer circle of signs corresponds with the electricity upon the outer surface of the back disk.

The inventor found by experiment that when two disks made of a flexible material were driven in one direction, they close together at the top and the bottom, while in the horizontal diameter they are repelled. When driven in the reverse direction, the opposite action takes place.

CAVEATS.

Few persons, out of professional circles, have a correct idea of the effect of a caveat, or in other words, know what a caveat is. Perhaps the most prevalent notion is, that a caveat is a short termed patent, obtainable for a very small fee; in other words, that a caveat has the same effect, or affords the same protection, as a patent, and that the only difference is that a caveat does not afford that protection for as long a time, and costs therefore very much less. Many also believe that the money paid for a caveat will count towards the cost of the patent afterwards. Nothing could be more erroneous, although it is true that the cost of a caveat is much less than the cost of a patent. As a matter of fact, there is hardly a point of similarity between a caveat and a patent.

What is a caveat? Experience has convinced us that it is practically impossible to explain the nature of a caveat within the compass of a business letter. Even in personal interviews we have had to cast the explanations in many different shapes before feeling that anything like a correct perception had penetrated the mist that had been created around the understanding of the questioner by amateur patent attorneys and by his own desire to secure protection at a less cost than that of a patent. The definition which we believe has generally had the most practical success is that "a caveat preserves your right to a patent for from three to twelve months." This of course is not strictly correct, but still it fairly embodies the essential idea as far as it is possible to compress it in a few words.

To be exact, we quote here the section of the Patent Act relating to the subject:

* Any intending applicant for a patent who has not yet perfected his invention and is in fear of being despoiled of his idea, may file, in the Patent Office, a description of his invention so far, with or without plans, at his own will; and the commissioner, on payment of the fee in this Act prescribed, shall cause the said document, which shall be called a caveat, to be preserved in secrecy, with the exception of delivering copies of the same whenever required by the said applicant or by any judicial tribunal,—but the secrecy of the document shall cease when the applicant obtains a patent for his invention:

2. If application is made by any other person for a patent for any invention with which such caveat may, in any respect, interfere, the commissioner shall forthwith give notice, by mail, of such application, to the person who has filed such caveat, and such person shall, within three months after the date of mailing the notice, if he wishes to avail himself of the caveat, file his petition and take the other steps necessary on an application for a patent, and if, in the opinion of the commissioner, the applications are conflicting, like proceedings may be had in all respects as are by this Act provided in the case of conflicting applications:

3. Unless the person filing a *caveat* makes application within one year from the filing thereof for a patent, the commissioner shall be relieved from the obligation of giving notice, and the caveat shall then remain as a simple matter of proof as to novelty or priority of invention, if required. 35 V., c. 26, s. 39.

The following quotation also fairly describes the nature of a caveat in a compact form:—

** A *caveat* is a document describing an invention under the oath of the inventor, which is filed in the secret archives of the Patent Office, entitling the person filing it to receive, during the 12 months following the date of filing, notice from the Patent Office if application is made for a patent by another person for the same invention. A *caveat* costs less than a patent, but affords an indifferent sort of protection for one year only. The money spent upon it, however, will not count towards the obtaining of a patent thereafter. It will not prevent any one making or manufacturing the invention. Any one may file a *caveat* in Canada, but only citizens of the United States can file *caveats* in the United States. A *caveat* is only then advisable if the inventor has any expectation of making further improvements in his invention and is afraid to be forestalled by others with what he already has got. A *caveat* can be renewed.

Thus it will be seen that a caveat is a kind of a contract between the inventor and the Patent Office, by which the latter undertakes to give the former notice if another person applies for a patent for the same invention within one year from the filing of the document, and not to take any action upon such an application before the caveator files his, provided he does so within three months of the notice. It follows, that should an application for a patent for the same invention be filed, say, on the day following the lodging of the caveat, the latter will only operate for three months, while if such an application should be filed on the last day of the year during which caveator is entitled to notice, it would hold his right practically for 15 months, because he need only file his application within three months of the notice.

It must also be noticed that the caveator will not be told whether a caveat for the same invention has already been filed, and that during the pendency or operation of caveat no exclusive privilege respecting the manufacture, sale or use of the invention exists, but that anyone is at liberty to manufacture, sell and use the same.

Nor must the caveator presume that the caveat secures the patent against all comers, because it would issue to the rival claimant, should he prove his priority as an inventor, in the interfering proceedings.

Only a few words more about drawings. It will be noticed that the Act leaves the attachment of drawings to a caveat optional. But as a matter of fact no caveat specification which admits of the use of drawings should be without them, as without them the description is apt not to be understood, misapprehended or overlooked by the official whose duty it is to compare them with the application. And it must be clear that the caveator's protection depends on his invention being readily understood from the papers filed. Of course, if the preparation be left to a patent attorney he will attend properly to that point. The usual cost of a caveat is $20.00. —*Patent Review.*

EXTRACTS FROM A MACHINIST'S NOTE BOOK.

We had a tool room with a fence around it—wire fence—right plump in the middle of the shop—had a young fellow in there who intended to be a machinist—some day; the only tool or appliance in that room, in the shape of shop equipment at which a machinist could amuse himself, was a gear cutter —no vice, mind you—not even a pin vice: and for this identical gear cutter we had about two day's work a month; this young chap could cut gears and the boss reasoned that when he was cutting them he could keep the gate locked and pass out the tools; when he was not cutting gears he was general roust-about; cleaning castings, sweeping the floor, babbitting boxes, killing time, painting machinery, and obtaining such miscellaneous mechanical and business experience incidental to the noble profession, while the sacred tool room enclosure became public common, even destitute of an intimidating "keep off the grass" bulletin.

About half an hour before quitting time each night this alleged tool room guardian would drop his work, go around the shop and hold up the boys for whatever tools they chose to shell out; if any one wanted any small drills or taps for private use, he carried home a lunch box full. What was there to prevent it? In the morning some duffer would be howling for the ⅜″ tap drill to finish his job; swears by everything holy that he turned it in last night with the rest of his tools, when he knows mighty well that he broke it just before quitting and threw the pieces in the sewer. Tool room chap spends fifteen minutes bothering all hands for this drill, and finally sends the kid over to the store for another; man with the unfinished job waits until he gets it, too. Where is the foreman all this time? Bless your heart, the foreman is busy!! He is what they call a working foreman; he is off at the other end of the shop running a vice, two planers, three lathes, and a couple of drill presses; the proprietor of this kind of a shop always has this kind of foreman, he does more work than any other three men; why? because he is working for the interest of the shop and the men are working for—nothing—nobody, in fact, they are not working at all half the time; they have no one to look up their material, tools, drawings, make sketches, calculations, or look ahead and so steer and engineer the work that the planers do not have to wait for the lathe hands, the drill press and vice hands wait for the planers, and a thousand and one of these many small attentions with which a brainy foreman can hustle work out of a manufacturing concern or a contracting shop. If the men never bother the foreman, he never bothers them; his sole ambition is to make a good showing, run the shop and get in from eight to nine hours a day on his own slate. The men have learned that he does not like to be bothered, and would do anything or nothing—principally nothing—rather than disturb him. Work is always in a jam; there is always some one who *could* be doing work on some piece if someone else *had* got through with it half an hour ago. The proprietor of this shop isn't rolling in wealth, exactly; and he sometimes wonders why he can't seem to strike luck and make a little on his contract work; has been so used to having customers send the work back to be fixed up a little, that he has to figure it in on his estimates, but can't quite see how he only gets about five per cent. of the work he figures on; his machinery and plant seem to compare quite favorably with his neighbors, while his foreman is a daisy, there is no disputing that fact; runs the shop, gets in eight hours a day, and only draws a salary of $25 a week, while many shops pay their foreman $30, and he don't do a confounded thing but stand around the place and figure.

Most respectfully, without any apologies.—CHIPPS, in *American Engineer.*

THE EBURNEUM PROCESS.

As the name implies, the pictures partake of an ivory character; in fact, they were photographs, principally portraits, on an artificial ivory.

The process was first introduced by the late Mr. J. M. Burgess, of Norwich, somewhere about five-and-twenty years ago.

The process, as worked by Mr. Burgess, was this: A transparancy by the wet collodion process was produced on glass, the plate, prior to coating with the collodion, being treated with wax to facilitate the subsequent removal of the film. In the development the image had to be kept exceedingly thin, while, as a matter of course, all the details had to be secured. As a rule the pictures were vignetted portraits. After the picture, or, rather, pictures—for in practice several were usually made on the same plate to save trouble—were developed, fixed, and finished, as transparencies, the plate was placed on a leveling stand, and the eburneum compound poured on. This consists of a solution of gelatine, with which was incorporated a white pigment—oxide of zinc being the one recommended by the inventor. To this mixture a small proportion of glycerine was also added, so as to prevent the gelatine becoming brittle when dry, and to secure flexibility. Sufficient of the compound was applied to the leveled plate to form, when dry, about the thickness of a thin mounting card. After the gelatine had set, the plate was reared up and allowed to dry spontaneously. When dry, the pictures were stripped from the glass and trimmed. They were then finished.

These pictures, when skilfully made, had all the appearance of being on ivory, such as that used by miniature painters, but without the objectionable grain.

The Eastman transferotype paper affords an excellent method of producing eburneum pictures of a high class. This method of making them would certainly commend itself to every one familiar with the working of bromine paper or the stripping films. The print is exposed in the ordinary way, but to obtain a warm tone a very full exposure should be given and the image brought out with a much diluted iron developer, keeping it somewhat thin, yet securing full detail. The picture is then transferred to collodionized glass plate, which has previously been talced, precisely in the same manner as when transferring a stripping film. The plate is then leveled and the fluid eburneum poured on and allowed to set, and afterward dry. When the picture is then stripped off, it is finished; or, in the case of sheet eburneum or ivorine, it is simply softened in cold water and squeegeed upon the glass in the same manner as the gelatine skin is treated in the stripping film process for negatives.—Br. Jour.

THE MILITARY BICYCLE.

The art of war is now borrowing from applied science all the resources that are at the latter's disposal, and there is nothing up to velocipedism that is not contributing to the service of the army. For a few years past, the Germans have been using the velocipede for the rapid carriage of despatches, and, on this side of the Vosges, the French have not neglected to put to profit the advantages of an analogous service, a corps of velocipedists having been organized in the army. The type of apparatus adopted is the bicycle, such as is seen in Fig. 1, which shows a French army velocipedist, during the period of a campaign, commissioned with the quick carriage of an urgent dispatch.

The English have gone beyond such a use of the velocipede for dispatch sending, and have endeavored to use it for the carriage of ammunition. A very curious experiment of this kind was very recently made at London with a multicycle apparatus constructed by a Mr. Singer.

This truly curious apparatus is shown in Fig. 2. It consists of a series of bicycles, six in number, each carrying two men and hauling a small vehicle loaded with ammunition. The bicycles are arranged in a single file, instead of being two or four abreast, thus much facilitating the operation of the apparatus and diminishing the surface of resistance to the wind. The speed on a good road varies from 9½ to 15 miles per hour. The rubber tires are made in such a way as to secure them from being injured, even on roads that are somewhat stony.

The starting of the whole is under control of the man who sits in front. Recently the affair was run through one of the most frequented streets of London, and was found to turn easily in a much more circumscribed space than could have been done by an ordinary carriage, and to turn with great speed through the streets without any accident resulting. The body of men selected to maneuver this multicycle consists of experienced volunteers, who are capable, in addition, of going through all military evolutions.

Fig. 3 shows another phase in the use of the military bicycle as practiced in England, the illustration of which we borrow from the *Illustrated London News*.

A small body of cyclists, ten in number (two sections and a half section), with officers and bugler, marching in usual order of half-sections—that is, by "twos"—are attacked by cavalry. At the word of command, "Halt!" "Prepare for cavalry!" "Form square!" each man dismounts; and the respective second half-section move up alongside their first half-section, so as to form a line of four men in front and rear, with a half-section of two men between them. Each man

Fig. 3.—Drill of English Military Bicycles.

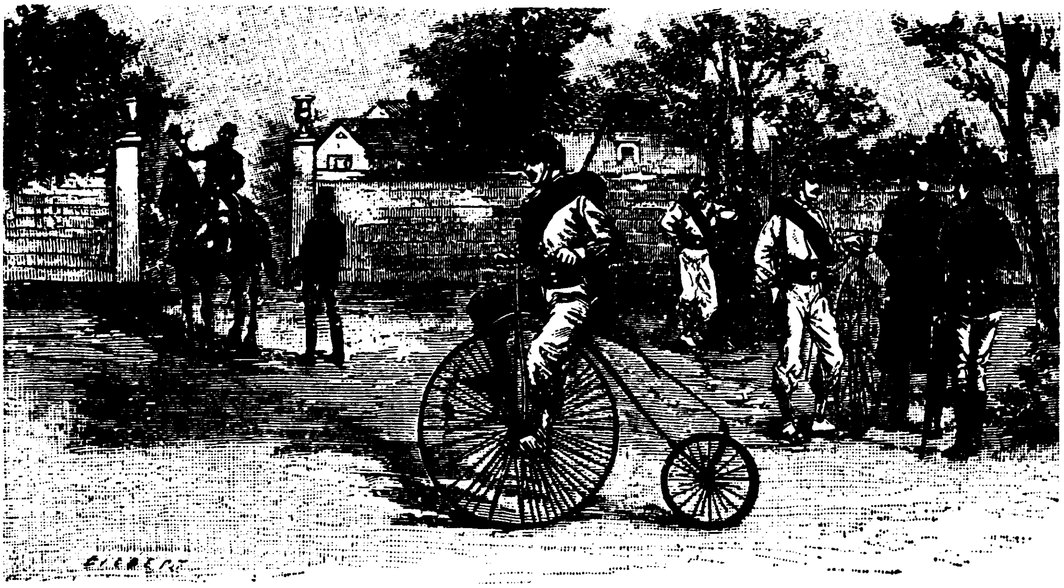


FIG. 1.—FRENCH MILITARY VELOCIPEDISTS.

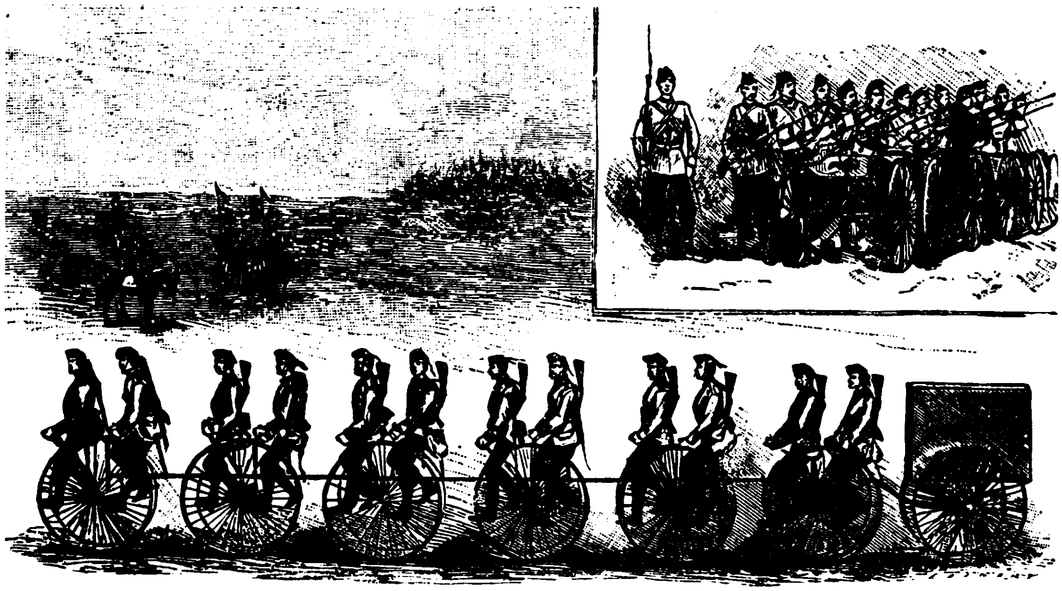


FIG. 2.—USE OF VELOCIPEDES IN THE ENGLISH ARMY.

then grasps his machine at the point of balance, and turns it outward, so that they form a square, with the men inside, each machine overlapping by a few inches those next to it.

The rifles are lifted out of their clips as the machines are lowered to the ground, and are then placed on the ground for a moment, while the machines are grasped with both hands by the framework and placed upside down, so as to stand in a reversed position, resting on their handle bars and saddles.

Lastly, each man, as he lies or kneels down behind his machine, sets his wheel spinning around with a touch of his finger. Such a fence, apart from the *chevaux de frise* of bayonets behind it, forms an obstacle which few horses, if any, would face; and the men inside, in perfect security, can pick off the advancing horsemen with deadly effect.

The position, so far as mounted horsemen are concerned, is practically impregnable; while the infantry rifles with which cyclists are armed, have great advantages, in accuracy and steadiness of aim, over the carbines of dismounted cavalry.—*Scientific American.*

EXTRACTS FROM A MACHINIST'S NOTE-BOOK.

I notice a thing about a shaper built by the Lodge, Davis, Co. of Cincinnati, which strikes me as being rather cute. The cross rail which carries the table and chuck is secured to the body-casting same as any other shaper of its class, by clamps and cap screws, except that instead of the cap screws being placed equi-distant along the clamps, the first two are quite close together, the third one being a little farther from the second, the distance to the fourth screw being still further increased, while between the fourth and fifth the space is about twice as great as between the first two, there being five small screws on each side. Thus the greatest strain, which is at the top, is met by the most resistance. I have never before seen the same good judgment displayed by gibbing in this manner.

Most builders make all the screws over strong and space them evenly. Time and material are saved in constructing on the first plan and when using this machine it is not necessary to exert so much muscle in screwing up these small, fine screws.

I know a manufacturer in the East by the name of——— well! I won't give him away just yet,—who makes four jaw independent lathe chucks and who makes the shoulders on the screws so infernally small that they bore out their seats in about four months use, rendering the cast iron body part of the chuck a very desirable article to have——in the scrap. I shall not buy any more of his chucks until he learns to make the body part of the screws large enough to leave a decent shoulder and wearing surface on their seats.

Do you know what a valuable thing for a shop a good emery wheel is? If so, why dont you have one in your place. I have been into over a hundred shops and have not found ten wheels in first-class order; in a very few places I find them running in pretty fair condition, but in the rest of the shops they hobble, bob and rattle around in the execrable condition best known to the average machinist.

What satisfaction does a man get in going to a wheel when all it will do for him is to either rub up a big burr on his work or knock it out of his hands.

When you buy a wheel if you want it for general shop use, let your dealer know it. If you want it for grinding hard steel, soft steel, chilled cast iron, wrought iron, cleaning castings, cutting brass, or for any other specific purpose, let it be distinctly known and you will probably be furnished with exactly what you need, as wheel manufacturers appreciate the different purposes for which their wheels are liable to be used and endeavor to grade them to fill the bill. You may know all this but there are a good many who do not. When mounting a wheel have it a perfect fit for the arbor and put thick paper washers between the wheel and arbor collars; have the whole thing perfectly balanced and drive it with a nice wide, flexible leather belt; having a wide belt saves straining it so tight. If the card on the wheel reads to run it 1200, speed it up to 1800, then it will cut; don't be afraid of it; have the boxes nice and snug and the arbor entirely without end movement so that when it is running at full speed no sound will be audible save the low hissing caused by friction between the wheel and air. Remember this: When a wheel cuts properly it does not leave any more burr than if the metal had been planed off, nor does it heat the work to any extent.

The faster a wheel is running the more rapidly will a spur dresser true it up; as each point and each spur disk acts as a single pointed pick taking off a small particle at each blow, the faster the blows, the quicker it is done. Keep the dresser within easy reach of the wheel so that any one may skim it off, who pleases; it only requires a few seconds and a wheel should never be suffered to get out of true $\frac{1}{64}$" or accumulate a particle of glazing. Most respectfully.—CHIPS, *in the American Engineer.*

ARTIFICIAL SILK.

One of the most interesting things shown at the late exposition in Paris, was a method of producing an artificial substitute for silk, possessing, in respect of appearance, lustre and strength, a very close resemblance to the product of the silkworm. Thus far, it would appear, the invention is in the experimental stage, and the manufacture of the new product has not yet been undertaken industrially, but, it is affirmed, that the cost of the manufacture will readily permit of the introduction of the artificial product as a competitor with the natural silk. The silk industry has of late years suffered many vicissitudes, especially by reason of the disease to which the worms are subject; but up to the present time, the idea of finding a substitute, acceptable in possessing all the good qualities of the natural product, was not thought of.

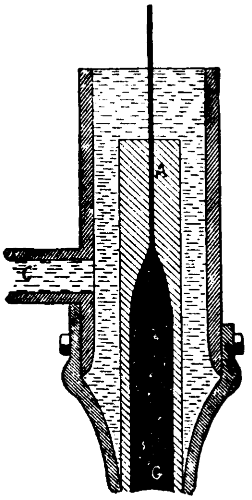
It has remained for a French technologist, M. le Compte de Chardonnet, to devise an original and most ingenious procedure for solving this apparently impossible problem. The raw material with which M. de Chardonnet starts in his process is pure cellulose—the basis of vegetable tissues—and for his purpose he employs paper pulp as the starting point of the industry. This he transforms into nitro-cellulose, produced by the well-known process of nitration in a mixture of nitric and sulphuric acids. The resulting product is a nitro-cellulose of the same character as that used by photographers in the production of their collodion, and in the manufacture of celluloid. After thorough washing and drying, the nitrated cellulose is formed into collodion by dissolving it in a mixture of 38 parts of ether and 42 parts of alcohol. The collodion thus formed is drawn into fibre by certain mechanical means to be presently described; but it requires first to pass through certain important preliminary operations. The collodion, as is well-known, is a highly inflammable substance, and this quality in the finished product would be very detrimental. It is, therefore, subjected to a process of de-nitration, by which it is re-converted to the condition of ordinary cellulose, in which state it is no longer dangerously combustible. The means by which this transformation is effected are not stated, but are kept as a secret by the inventor. Chemists, however, are familiar with a number of processes by which this operation may be performed, certain reducing agents being employed for the purpose.

The thread, after this treatment, may be rendered quite incombustible, if desired, by passing it through a solution of some one of the salts commonly employed for rendering textile fibres fire-proof (phosphate of ammonia, for example), and at this stage of its manufacture the fibre is dyed of any desired color.

The mode of producing the filaments of collodion is extremely simple. The model shown at the exposition, consisted of a glass tube, reduced at its upper end to a capillary passage. Through this passage the filament of collodion is forced out under pressure; as it issues, the fibre is in a pasty condition, and requires immediately to be consolidated. This is effected by a second glass tube surrounding the first. Connected to the second tube is a small pipe, which supplies a current of cold water that at once "sets" the pasty collodion filament, so that it can be caught by pincers and drawn out without breaking. It is then led to a spool, on which it is wound.

In London *Engineering* we find a sketch of the model apparatus, which we reproduce, and from this a clear idea may be obtained of the procedure of forming the collodion filament. Referring to the annexed sketch, A is the capillary tube; B is the exterior water jacket for consolidating the fibre as it issues from the first; C is the feed-pipe supplying water to B; D is a rubber connecting piece; F is the filament of artificial silk; and G, the mass of the collodion.

The inventor exhibited, in addition to the model just described, an apparatus containing a number of such tubes, with which he illustrated the method of twisting several of the filaments together to form a thread. Another machine was arranged for showing the practical working of the system. From the account given by our contemporary, we learn that



APPARATUS FOR MAKING ARTIFICIAL SILK FIBER.

in this the dissolved collodion was contained in a copper vessel having a capacity of 15 litres. From this reservoir the dissolved collodion was forced out under a pressure of 8 to 10 atmospheres, through 72 capillary tubes surrounded by a water jacket, as above described. By this means, 72 filaments are produced at the same time, and these may be spun into threads of various thicknesses—from such as are formed of 3 filaments as a minimum, to 10 as a maximum. To effect this, there is a rack placed parallel with the horizontal tube, and carrying a series of bronze blades that serve to guide the filaments. The twisted threads are wound upon bobbins running on spindles mounted parallel to the horizonal tube. A frame carrying as many pincers as there are capillary tubes, can be put in motion by a cord, and if any of threads are broken, these pincers take hold of the filament and unite the broken ends. The apparatus is enclosed in a hermetically sealed glass case, through which a current of air is continually forced. This air is warmed, to facilitate the drying of the filaments, but is sufficiently cooled down at the exit place to deposit the vapors of ether and alcohol derived from the dissolved collodion. The circulating water is discharged into a receiver, and the considerable quantity of alcohol and ether retained therein is regained by distillation. By this precaution, the loss of ether is reduced to 20 per cent, and that of alcohol to 10 per cent. One of these tubes can produce from 3 to 5 cwt. of filament per hour, corresponding to a length of 1¾ miles. The apparatus here described is said to have worked continuously, and to have required very little attention. The artificial product thus produced, it is said, can be sold at from 15 to 20 francs the kilo., while raw silk costs from 45 to 120 francs the kilo.

The resemblance between the natural and artificial products is said to be very close. The latter is smooth and brilliantly lustrous, and has a strength about two-thirds that of natural silk. When woven into a fabric, the artificial fibre is said to be stronger, and to be less liable to cut than the natural silk, these advantages being due, it is explained, to the fact that the artificial filament is not charged with destructive substances, such as zinc or lead salts, which are commonly used in dyeing silks. These metallic salts serve the purpose, principally, of weighting the silk. The density of the artificial product, according to the inventor's figures, lies between that of raw and finished silk; its resistance to tensile strain varies between 15 and 22 tons per square inch. The elasticity of the artificial silk is said to be about the same as the natural, and the inventor claims that the former is superior in brilliancy to the latter. M. de Chardonnet exhibited a number of specimens of stuffs woven wholly from his artificial silk, as well as others in which his product was mixed in with silk and other textile materials. The results attained are said to be really remarkable.

It is said that the industrial application of this most interesting process is shortly to be made, and we shall look with much interest for the outcome.—*The Manufacturer and Builder*.

THE INJECTOR.

Since the injector was invented by Giffard, and brought into practice, it has generally done its work satisfactorily, and at a fairly small cost for feeding steam boilers. It was a great novelty when first introduced, and soon became a favourite among engineers, whether locomotive, marine or stationary. The cause of its popularity is not far to seek, as it acts entirely independent of the engine, and can therefore be put on or off at any time.

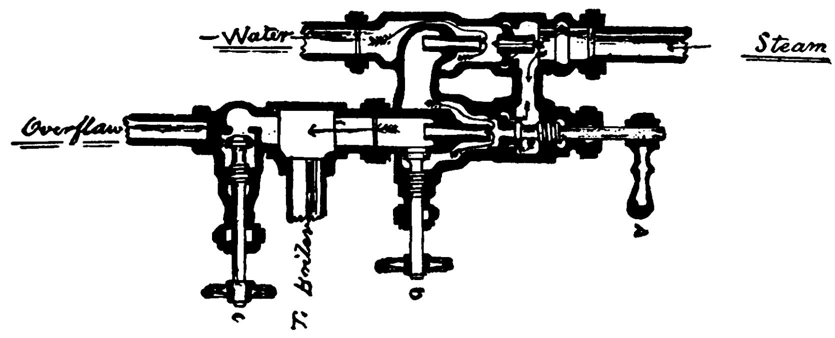
Before the injector came into use, it was not an unfrequent occurrence for locomotive engineers to draw their fires, when side tracked, or delayed by an accident in front, and thus save their furnace sheets. To do such a thing in these days would be to degenerate to the old style. This applies also to a stationary boiler. It is not in these days at all creditable for a stationary engineer to draw his fires for low water, when for a comparatively small sum an injector can be attached to any boiler.

Probably no invention was ever placed in the hands of engineers, that has been accorded such a small amount of thought and investigation, and which, nevertheless, we have been able to work so efficiently. Very few of us have taken the pains to investigate and find out the cause or action by which this instrument can deliver water into the same boiler from which it is supplied with steam.

Of course, if an injector will not work, we take it down and dissect it, and look for the objectionable bit of dirt, etc. Should it fail again, we test our suction pipe to see that it is perfectly tight, examine our feed water to see that it is not hot, and then if it won't work—well, we can't do any more.

The action of the injector or inspirator is entirely due to the concentration of the steam issuing from the steam cone, which can be taken as representing the power of the instrument. Here the steam is condensed, and is concentrated by means of the water coming in from the water inlet. The united streams of water and steam are passed on into the receiving cone, and here it is that the resistance to the entry of the water into the boiler is experienced. The sectional areas of these cones differ as a matter of course. The areas of the steam and water cones are about as 2.0106 is to 0.7854 at their smallest diameters. The injector takes advantage of the superior velocity with which steam issues from a boiler as compared with water, and may be regarded as an instrument for producing a combined jet of steam and water, flowing through a nozzle at a higher velocity than that at which a corresponding stream of water would issue from the same boiler that supplies the steam.

When the water comes within the scope of the current of steam, it is carried along by the concentrated steam acting



upon it. The water, which is incompressible, is projected forward into the delivery pipe, and thence into the boiler by the impulsion force of the steam, the velocity of the steam being due to its elastic pressure. It can be likened to a rifle or gun, inasmuch as the expansive force of gunpowder is confined by the lead to the powder chamber, where the force is concentrated that ultimately sends the ball hissing through the air. So with the action of injectors, the force is concentrated by the water at the cone, and instead of their being one effect, as with a charge of powder for one shot, the injector, while steam is on, is always charged, and there is a continuous discharge of water.

The reason why an injector will not work with feed water of a greater temperature than 130° to 150° is, that it requires so large a quantity of water to condense and concentrate the steam issuing from the steam cone, that the necessary speed of water to overcome the resistance to entrance of boilers can't be obtained, and the consequence is, the machine will "kick." The ratio of the quantity of water entering the boiler to that of steam used is as about 18 to 1—that is to say, roughly speaking, for every 18 lbs of water injected into the boiler, 1 lb. of steam is used to operate the injector. The temperature of the feed water after passing through the injector is raised from 75° to 100° when the pressure on boiler is about 70 lbs. per sq. inch.

Now we will assume that, after an injector has been at work for some time it throws off—stops working. There are at least three causes by which a stoppage may be produced :

1st. The injector will throw off when the feed water exceeds a certain heat, for the reasons before mentioned; but it may be argued, that as the injector took the water and worked for a short time at first, why not continue to do so ? The answer is : because the injector itself may have been cool when first put on, and thus cool the steam to a greater or less degree, until itself became heated.

2nd. The water in the tank may not have had the same temperature throughout, and as the hotter water entered the injector, it failed to condense and concentrate the steam.

3rd. The injector will throw off, when the volume of issuing steam from boilers is insufficient to give the required speed to the water, so as to overcome the resisting pressure of the water and steam in the boiler. Here again it may be said : "But the injector worked at first ! " yes ! but the water that has been put into the boiler has reduced the temperature of the steam, and consequently its velocity is reduced in proportion, while the volume of water entering the injector remains the same as when it was first put on ; therefore the steam is condensed, and still there is not sufficient force given the water to overcome the pressure of steam and weight of water within the boiler.

There are many injectors bearing different names but they all work on the one principle. The Hancock Inspirator is an American invention. It is a double apparatus, as will be seen by the sketch, one half operating as a lifter, and the other half as a forcer, consisting of a forcing jet and forcing nozzle or injector ; the lifter drawing the water and delivering it to the forcer, which in its turn delivers it to the boiler.

Although both the lifting and force nozzles are fixed, their proportion one to the other is such that the inspirator does not require any adjustment for changes in steam or water supply. By means of the inspirator, water can be lifted twenty-five feet, and delivered into a tank or boiler, as required, with a steam pressure of 30 lbs. per sq. inch.

The temperature of the feed water may be as high as from 90° to 100° Fahr. for a lift of 25 feet ; or it may be as high as 125° Fahr. for a lift of 3 or 4 feet. The inspirator for stationary boilers as shown in section, has three valves. By means of the valve A, the admission of steam to the forcing jet is controlled. By the middle valve B is regulated the flow of water delivered by the lifting jet into the forcing tube. By the lower valve C, the overflow is opened or closed. There is a Hancock inspirator manufactured, which can be operated by one lever, thus doing away with the opening and closing of so many valves. It is the same in principle as the machine which we have shown on the sketch, and is self-contained. It operates in this manner : By a slight movement of the starting lever, steam is admitted to the lifting jet. When water issues from the overflow, by a further movement of the lever one of the valves is closed (thus turning the supply water through the force nozzle) steam is admitted to the forcing jet. Then the waste valve is closed. Then (everything being in order) the instrument is at work.

An elaborate series of trials of the Hancock inspirator was conducted at Boston by Mr. R. H. Bush. According to a table of some of the results of these trials, with a No. 30 instrument, in which the smallest diameters of the force nozzle was 0.30, or nearly 5-16 of an inch, when the lift was from 2 to 3 feet, and the temperature of the water was 70° Fahr. while the pressure of steam supplying the instrument as well as the pressure against which water was delivered, varied from 15 lbs. to 150 lbs. per sq. inch, the maximum rate of delivery when the steam valve was wide open and supply throttled, was from 60½ cub. ft. to 78 cub. ft. with steam of 140 lbs. The temperature of the water at maximum delivery, varied from 103° to 193° Fahr. At maximum delivery, when the steam valve was open wide, and supply throttled, the temperature varied from 184° to 230° Fahr., under pressures of from 40 to 150 lbs. per sq. inch ; and at minimum delivery, with steam valve throttled, and supply valve opened wide, the temperature varied from 134° to 168° Fahr., under pressures varying from

80 to 150 lbs. per sq. inch. The vacuum in supply pipe varied from 4 inches to 23½ inches, between the extreme pressures of from 15 to 150 lbs. The lowest pressure of steam with which the inspirator delivered water against these extreme pressures, varied from 11 lbs. to 90 lbs. per sq. inch. Some inspirators will work with 150° Fahr.

In conclusion I would say, that in my estimation an injector is a necessity in any boiler room, as it is a friend in need, but for a steady, reliable boiler feed, a good pump, either power or steam, can't be beat. The time when an injector proves a friend, is when the pump goes back on us.—ALBERT E. EDKINS, *in the Electrical, Mechanical and Milling News.*

RAPIDITY OF MOVEMENTS.

Science says a pianist, in playing a presto of Mendelssohn, played 5,595 notes in four minutes and three seconds. The striking of each of these notes, it has been estimated, involved two movements of the finger, and possibly more. Again, the movement of the wrists, elbows, and arms can scarcely be less than one movement for each note. As twenty-four notes were played each second, and each involves three movements, we would have seventy-two voluntary movements per second. Again, the place, the force, the time, and the duration of each of these movements was controlled. All these motor reactions wer conditioned upon a knowledge of the position of each finger of each hand before it was moved, while moving it, as well as of the auditory effect to force and pitch, all of which involves at least equally rapid sensory transmissions. If we add to this the work of the memory in placing the notes in their proper position, as well as the fact that the performer at the same time participates in the emotions the selection describes, and feels the strength and weaknesses of the performance, we arrive at a truly bewildering network of afferent and efferent impulses, coursing along at inconceivably rapid rates. Such estimates show, too, that we are capable of doing many things at once. The mind is not a unit, but is composed of higher and lower centers, the available fund of attention being distributable among them.

NEW BOOKS.

CHEMICAL AND PHYSICAL STUDIES IN THE METAMORPHISM OF ROCKS. By A. IRVING, D.Sc., B.A., F.G.S. London : Longmans, Green & Co., 1889.

The title of this little book will cause it to be hailed with interest by geologists the world over. Our knowledge of the details of rock metamorphism is so imperfect and so chaotic that any attempt to enlarge it, or to reduce that which we now possess to order, or to throw out any new suggestions which will help to clear existing obscurity, will always be eagerly welcomed by workers in this branch of science. For the satisfactory treatment of so difficult a subject, however, it is requisite that the author should be a geologist of mature experience, and free from prejudice or desire to air his special views as to the development of the Archæan crystalline rocks to the disparagement of the views of more experienced investigators. In these particulars our author does not, unfortunately, show himself to be well qualified for the task he has undertaken. It is apparent throughout the work that his experience is extensive as a chemist but not as a geologist or lithologist ; and his special pleading for his own entirely unsubstantiated views of Archæan geology in a work that purports to be an impartial discussion of rock metamorphism is a decidedly objectionable feature of the book.

There are, however, many good points in the book, and the author has done well to direct attention to the bearing of chemical studies upon geological problems and to insist upon their importance. The most valuable part of the book is not the theoretical discussions, but the *facts* which have been got together in its compilation. To have these facts, a number of which are new and contributed by the author, properly arranged in the compass of a small volume, will be a great convenience for reference. And in this respect the appendices, comprising some 35 pages, are, perhaps, the most useful portion of the book. In the body of the volume our author treats of the different kinds of metamorphism under three heads :—

1. *Paramorphism*, including all those changes within a rock mass (essentially of the nature of chemical change), in which the original minerals have had their chemical composition more or less altered while new minerals are formed within the mass.

These changes are *atomic*.

2. *Metatropy*, or changes in the physical characters of rock masses, while there is no essential chemical change either in the rock mass or in its constituents.

These changes are *molecular*.

3. *Metataxis*, or changes of order of the constituents of the rock mass, of which the phenomenon of slaty cleavage may be taken as typical.

These changes are *mechanical*.

These various kinds of metamorphism are discussed chiefly in the light of laboratory experiments, and the possibilities of analogous processes being carried on in nature are pointed out in considerable detail. Among the more interesting topics considered may be mentioned the relationship between vitreous and devitrified conditions of matter ; and the bearing of the "critical state" upon changes in rocks. A clear and instructive account is also given of the process of "hyperphoric change."

Contact metamorphism is discussed at some length, and three stages are distinguished :—

1. First stage due to the effects of heat and pressure.
2. Second stage due to effects of circulating superheated water.
3. Third stage, changes following upon cooling.

In questions of Archæan geology our author holds the views of the extreme plutonic school, which rejects absolutely all the abundant and perfectly good evidence of the metamorphic derivation of part of the Archæan from normal surface-formed sedimentary and volcanic rocks, and asserts that the whole Archæan complex represents the first formed crust of the globe when it cooled from a liquid to a solid state. It seems difficult for these geologists to apprehend that the Archæan is a complex consisting partly of altered or metamorphic rocks and partly of igneous plutonic rocks, the latter being irruptive into the former, so that the igneous rocks could not possibly have been the first crust of the earth, but represent the consolidation of sub-crustal magmas which pierced the crust from below when the latter was constituted of normal strata.