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LEATHER BELTING.

BY C. F. KINSEY.

The following interesting paper prepared on the above subject was read at a recent meeting of the Stationary Engineers Association of Toronto, by Mr. C. F. Kinsey, of this city :—

There are two kinds of leather belts, known as oak belting and hemlock belting respectively. The difference between the two is, that the oak belting is tanned with oak bark, or an essence of oak bark, and the hemlock with hemlock bark, or an essence of hemlock bark. Those engineers who are not acquainted with the two sorts on seeing them together would probably notice that one belt was lighter colored and much smoother in appearance than the other. The light colored one is the oak belt, and the dark red one the hemlock belt. The difference in the color is easily detected if they are both properly made.

It sometimes happens that on an oak belt you will perceive dark stains or black places. This tells its own story, viz., that in the dark places the belt was not scoured properly, or, as it is called in a belt shop, the bloom or essence of the oak tan was not raised. The same thing is sometimes seen in a hemlock belt, but owing to its reddish color it does not show so much as on an oak belt. Whether or not these dark stains are a detriment to the wear of the belt I am not prepared to say; it is certain, however, that they alter the market value considerably.

Now as to the wearing qualities of the two belts. If I was asked which I thought was the best of the two I would most decidedly vote for the oak belt, because it has far more workmanship put into it than the other one. Another reason is that the oak belt is firmer and finer than the hemlock belt. Hemlock belts as a rule (so far as my knowledge goes) are generally a little soft to the touch, and I think if they are put to extraordinarily hard work, a few years will wear them out. As I never had a new belt of either sort to work throughout its natural life, I could not say which will last the longest. I do know, however, that an oak belt costs far more than a hemlock belt, and am inclined to think that if two articles of a kind show such a difference in price, one must have earned a better reputation than the other, and the only way for a belt to earn a reputation is by doing a certain kind of work for a long term of years.

It is just possible that some engineer may wonder if his belt is made of good material. A very simple way to test it, is taken from Roper's book; cut a slice off the belt about $\frac{1}{16}$th of an inch thick and half an inch long; put it in vinegar; if it is well made, it will stay leather for months; if it is poor leather, the fibres of the leather will swell and it will become like a piece of glue. I have tried this method myself, and found it correct.

I propose now to give you an idea how to get a belt and how to keep it in working order. The points to be borne in mind when calculating for belting are: power to be transmitted; speed per minute; distance from centre to centre; and whether the belt runs in a horizontal, inclined, or vertical position; the diameters of the pulleys used; width and thickness of belts, and the material of which the belt is composed; whether the belt is open or crossed; its tension, and the area of its contact; also the general conditions under which the belt has to work. A belt for driving high speeded machinery should combine, as far as possible, uniformity in thickness and width, pliability and smoothness, closeness and adhesiveness of grain made from the backs of carefully selected hides, and be well stretched before using, even joints of sufficient width to transmit the required power without straining the band joint. Wide belts drive better than narrow ones; a loss of power is largely increased through curling up at the edges. New belts do not bed themselves so well on the pulleys as when they are older. Belts should never be allowed to get greasy or glazed over, as their driving power is thus lessened. In calculating the transmission of power by means of belts, a considerable margin must be allowed for slipping. If it is neccessary to run at short centres and the slipping is excessive, the pulleys should be covered with brown paper. Never use resin to make the belt grip, as it acts injuriously on the leather. For transmitting power for high speeded wood-working machinery, the belts, owing to their becoming hard and dry, should be made about one-fourth wider than is found necessary in other kinds of machines running at slow speeds. As I have said before, it is also very necessary that the belts should be uniform in thickness, with nice even joints to avoid jumping on the pulleys. Twisted belts should be avoided as much as possible. A double belt should never be run over a pulley less than 24 inches in diameter as they very soon crack and are then ruined.

The best way to put a belt on pulleys is to put the smooth or hair side to the faces of the pulleys. One reason for this is, that belts have a better grip on pulleys, owing to the two smooth sides coming together and so excluding the air, and I believe myself that a partial vacuum is formed underneath the belt and the atmospheric pressure makes it grip the pulley all the tighter. Another reason is that it prevents the belt from cracking.

A tight belt should always be avoided. You may increase the power of the belt, but make sure if you tighten it too much, the constant strain will soon break it. If your belt is not powerful enough, it is far better to put on a wider one, and use the other for something else. A belt should not run faster than 30 feet per second, nor have tension of more than 300 lbs. per square inch of sections, and the machinery should be so planned that belts will not have to run in a vertical line; the direction of the belt should be from the top of the driver to the top of the driven.

In fastening belts on pulleys, there are several good ideas that I have seen in the way of hooks, staples, etc. I still use the old-fashioned plan of lacing, but no matter how you fasten a belt, you must do it so that it will run round the smallest pulley without jumping. I might say, that in lacing, you should lace from the centre, make the holes oval, and tie the knot in the centre and on the outside of the belt. For myself, I would never have a laced belt if I could so arrange it as to have an endless one, especially if it has to do very heavy work. I always consider that a laced joint is a great weakness, and I know it is a source of anxiety, for one never can tell when it will give out unless the practice is followed of looking at it daily. Some firms have an idea that they have saved a few dollars by getting a belt without a lap joint to make it endless; but the engineer does not think so. These hints that I have given on fastening belts, are for those engineers who are unfortunate enough to have to lace or fasten them.

Perhaps some of my engineer friends would like to make a lap joint when that irresistible desire to be working at something seizes them, so I propose to tell you how to go about it. In the first place, plane the two ends down level, until the lapped joint is the same thickness as the belt; scrape off all the uneven places left by planing until you have a level surface for joining; get some good cement and spread it quickly over the two ends; put the ends together and clamp them between two warm plates of stiff iron; if you have no clamps, put them in the vice, and in about an hour the belt will be ready for work. From the works of M. Powis Bale, I copied the following table of the different laps required for various sized belts:—

Width of belt in inches..	1"	2"	3"	3" to 6"	6" to 8"	Above 8"
Amount of lap in inches..	3"	4½"	5½"	6"	8"	10"

In most cases after a belt has been at work a short time, it stretches out considerably and begins to slip. Anybody could say that it wants tightening or drawing up, but just how to do it, and do it right, is the problem. To those engineers who make a practice of throwing the belt off and tightening it, then forcing it on again by hand, I would say, don't do it again, for you surely make one side longer than the other, and a loss of power is the result. Always shorten a belt when it is in its place with stretchers. They can be hired or borrowed from any belt shop, and if not, then make a stretcher of your own. Another question is: how much may it be taken up without injury to the belt? From the above mentioned work I give the following rule: When putting on a new belt, draw it up one inch for every five feet of its length, and in taking it up for the first time draw it up one inch for every 10 feet of its length; for the second time, one inch to every 20 feet, and so on.

An engineer may look at his driving belt, and wonder to himself what power his belt is developing or would develop under favorable circumstances. The following rule taken from the *Practical American*, says for leather belts, the product of the speed of a belt in feet per minute with its width in inches, is equal to 500 times the horse power transmitted. From these rules we may calculate: 1st, the horse power which a belt of given width and velocity can transmit; 2nd, the velocity with which a given belt has to be run to produce a given horse power; and 3rd, the width necessary for a belt to transmit a given horse power with the speed it is running the pulleys.

First Rule.—Multiply the speed of the belt in feet per minute with its width in inches, and divide by 500; the result will be the horse power. Example—suppose a belt is running with a velocity of 2,500 feet per minute with a 16 inch wide belt, what horse power will it develop?—2,500 × 16 ÷ 500 = 80 horse power.

Second Rule.—Multiply the horse power by 500, and divide by the width of belt in inches; the result will be the velocity in feet necessary to transmit the power. Example—suppose you require 100 horse power with a 20 inch belt, what must the velocity be at which it must run?—100 × 500 ÷ 20 = 2,500 feet per minute.

Third Rule.—Multiply the horse power by 500, and divide the product by the velocity of the belt in feet; the result will be the width in inches required to transmit the power without slipping. Example—what must be the width of a belt for a 150 horse power engine, the belt travelling at the rate of 2,500 feet per minute?—150 × 5,000 ÷ 2,500 = 30 inches wide.

These rules hold for moderate sized belts. Very large belts need not be so wide, but may be 20 per cent. narrower than medium sized ones, while for very narrow ones the width must be taken more by some 20 or 30 per cent. We may deduce from this a rule easily remembered; it is that for every horse power, it takes one inch of belt if it runs at the rate of 500 feet per minute, and that the horse power increases in the ratio of this velocity. I may say these rules apply to single belts. Double belts are 3·5 stronger than single ones, therefore they need not travel so fast or be made so wide as the other belts to do the same work.

Rules laid down by some engineers make the diameter of the smallest pulley by a direct factor of the force which should be transmitted. Others make the length of belt in contact with the pulley such a factor. Others make the force transmitted as the arc of contact, or proportion of the circumference of the pulley enveloped by the belt.

Three forces are principally concerned in transmission of power by a belt: First, its tension on the driving side; secondly, its tension on the slack side; and thirdly, its adhesion to the pulley. The difference between the first and second is the net force transmitted, and cannot exceed the third. It is necessary first to inquire what tension can be continuously applied to the driving side without injury. The question then will be: What other, and less tension applied to the slack side will produce an adhesion at least equal to the difference between the two tensions?

The subject has been investigated mathematically by Rankine, and experimentally by Morin and others. A paper contributed to the *Journal of the Franklin Institute* by Mr. Robert Briggs, gives the result of some investigations made by himself and Mr. H. R. Towne, and is of great practical interest. The same paper is also published in Mr. J. H. Cooper's "Use of Belting." The greater or driving tensions were taken at 67 lbs. per inch wide, or one-third the ascertained breaking strength of the laced joinings of single leather belts, and the co-efficient of useful friction at six-tenths of that established for sliding friction. By their own experiments, as well as those of Morin, it was found that with equal areas of contact, the adhesion did not materially differ on pulleys of 12, 24, or 42 inches in diameter. Their experiments, as well as a number of examples cited, confirm their theoretical conclusions. The results are summarized in the following table, which gives for arcs of contact from ¼ to ¾ of the circumference, the net force which should be transmitted for each inch in width of single leather belt :—

Arc of Contact.	Lbs. per Inch.	Arc of Contact.	Lbs. per Inch.
90°	32.33	150°	44.64
100°	34.80	180°	49.01
110°	37.07	210°	52.52
120°	39.18	240°	55.33
135°	42.06	270°	57.58

For convenience of memory, these results may be approximated by the use of the following rule: To one-seventh of the number of degrees of contact, add 21 ; the result is the force in pounds per inch wide, which should be transmitted.

The single leather belt, laced, is in such general use that its strength must be taken as the basis in the arrangement of general machinery. Mr. Towne found the strength of rivetted belts to be about 80 per cent. greater than laced ones. A few have been known to last a long time under tensions twice as great as those indicated by the above table. But tensions one-third greater than those of the table are about as high as can be applied to single rivetted belts of average quality, without unequal stretching, and consequent loss of durability.

In our association meetings and our school meetings, we have often had lessons given on the strength of boiler plates and the strain or pressure they are safe to work at ; also what pressure would burst any boiler plate. I think an engineer may sometimes look at his belt and think to himself, what strain will that belt stand to burst or break it.

I propose to give you an idea how to work that out. The strength of the best hides used for belting has been calculated at about 3,086 lbs. per square inch of section. This is reduced at a rivetted joint to 1,747 lbs. and to 960 lbs. at a laced joint. One-third of these figures may be considered a safe working strain. As belts vary very much in thickness, the following table in lbs. per inch width of safe working strain may be of use :—

Thickness of Belt.	Working Tension.
3-16 inches	60 lbs.
7-32 "	70 "
¼ "	80 "
5-16 "	100 "
⅜ "	120 "
7-16 "	140 "
½ "	160 "
9-16 "	180 "
⅝ "	200 "
11-16 "	220 "
¾ "	240 "

Another way of measuring the power of a belt, is to get an ordinary two-part clamp with a hook on the back, and fasten the clamps tight on the belt. To the hook fix a spring scale, and fasten the scale to the nearest wall or timber that will give a direct pull. Throw the belt over the driving pulley of the engine ; hold the other end tight on the pulley, and set the engine off. The moment the belt slips, the reading of the scales is taken, and that is the actual resistance or tension of the belt on the pulley. This multiplied by the speed of the belt per minute gives the total foot pounds transmitted by it for the time reckoned.

In conclusion, I would like to give you a couple of recipes —one for fastening your belts, and the other for making them pliable :—

Cement for Leather Belting.—Common glue and isinglass, equal parts, soaked for ten hours in just enough water to cover them ; bring gradually to a boiling heat, and add pure tannin until the whole becomes ropy, or appears like the white of eggs.

For making belts pliable, castor oil is good, besides making the belt vermin-proof. It should be mixed half and half with tallow or oil. Pyroligneous acid will preserve leather from moulding, and will remove the mouldy places by first rubbing with a cloth, then applying the acid.

A little advice on belting may not be out of place here. To those engineers who have full power to get their own supplies of everything round their engines, I would say, when the time comes that you require a belt, always buy the best that money can buy. The best is always the cheapest in the long run. To those engineers who do not enjoy the confidence of the firm they work for, and are not allowed to select their own supplies but must first consult a foreman (in many cases a man who never devoted five minutes of his life to studying these things), show him the benefits to be derived from getting a good belt. A cheap belt is always a poor one. I have seen them made, and have drawn my own conclusions a long time since.

When once you have a belt, take care of it. It will pay you for all the trouble you bestow on it. Keep it well dusted and free from moisture. If you see the least curling of a joint, if you can repair it, do so ; if not, report it to somebody who can. I believe in the old saying, that "a stitch in time saves nine." I know it is true with regard to belts.—*Dominion Mechanical and Milling News.*

NICKEL PLATING.

The following solution for electro-plating with nickel is used by several firms in Hainault: 500 grms. of nickel sulphate, 365 grms. of neutral ammonium tartrate, 2·5 grms. of tannin dissolved in ether, and 10 liters of water. One and one-half liters of water are first added, and the mixture boiled for fifteen minutes. The remainder of the water is then added, and the whole filtered. The *Electrician* says—"Solution yields an even white deposit, which is not brittle, and the cost of which is hardly more than that of electro-plating with copper."

Nickel-plating is now effected at several works in Belgium with the following bath :—Sulphate of nickel, 1 kilog.=2·2 lb.; tartrate of ammonia, 0·725 kilog.; tannic acid with ether, 0·005 kilog.; water, 20 liters=4·4 gallons. With this formula a thick coat is deposited on all metals in a short space of time, and by a weak current.

White birch is the favored wood in the manufacture of toothpicks, the wood being delicately white as well as sweet to the taste, and there is a constant demand for the goods at a little less than $2 a case of 150,000 picks. At Harbor Springs, Mich., the birch logs are sawed, steamed, and cut into ribbons three inches wide ; these are run through the machinery, eight or ten at once, and fall in finished pieces into baskets placed for their reception. The packing is done principally by expert Indian women.

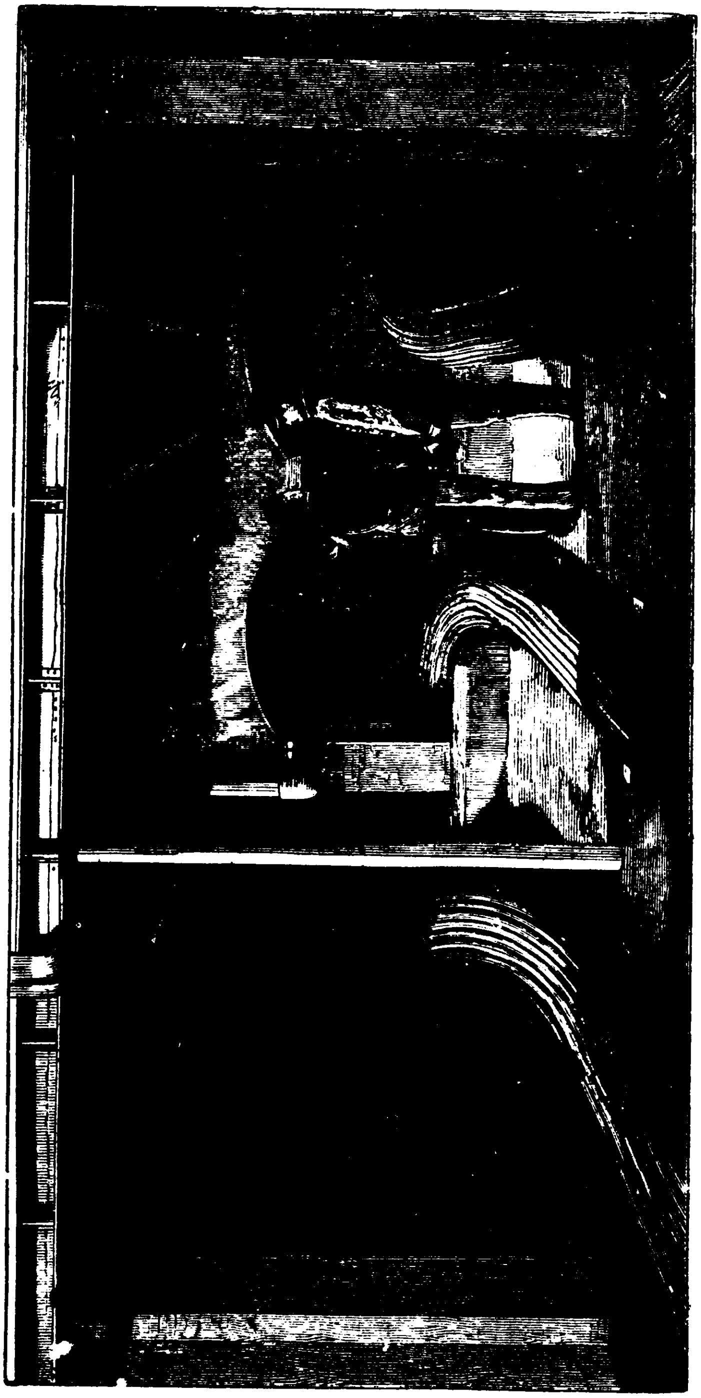


Fig. 1.—Cellar, Showing Terminals of Subways and Entrance of Telephone Cables.

THE METROPOLITAN TELEPHONE CO'S. NEW CENTRAL STATION AND GREAT SWITCHBOARD.

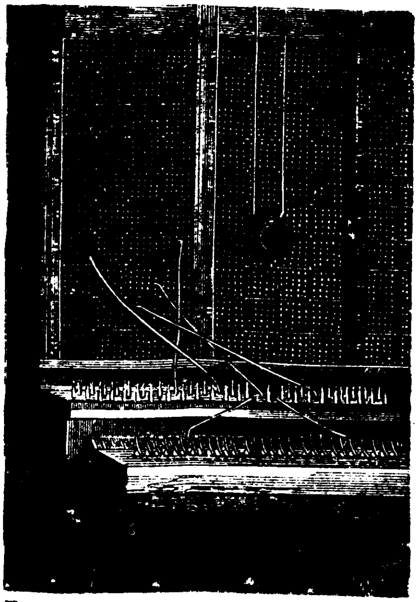


FIG. 2.—ARRANGEMENT OF SPRING JACKS, SWITCHES, AND ANNUNCIATORS ON SWITCHBOARD.

The Metropolitan Telephone Company, of New York, have recently erected a new central station building in Cortlandt Street, which is of special interest as embodying the latest improvements in telephone central station work and accessories, as well as containing the largest switchboard in the world. At present about 2,500 subscribers use it, but all the connections are prepared for 6000, and the board can be extended so as to include 10,000. The building is fireproof throughout.

The cellar is excavated under the sidewalk and roadway of the street. In its front end are the terminals of several subway conduits partially occupied by cables. At present forty-nine lead-incased cables enter the building (Fig. 1). Each cable contains about one hundred wires, arranged in pairs, the wires of each pair being twisted about each other. The object of this disposition is to ultimately use the wires in complete metallic circuits, the twisting of each pair being for the purpose of reducing induction. At present ground circuits are generally used, so that nearly one-half of the wires in these subways are idle. The cables run thence to the testing room (Fig. 7). The wires from the street lines are connected to binding screws. House cables run up from this room to the top of the building, where the switchboard is placed. The ends of the street cables are opened, and the pairs of wires are kept separate, and, by testing with a bell and battery, are traced to their out-door terminals. Each pair is numbered, and connected through the box with corresponding binding screws. The same operation is performed in the building for the house cables leading upward, and by the connection boxes all is placed in correct circuit. The wires are all india-rubber coated.

Entering the switchboard room, they are distributed on the cross connecting board along the walls, thence communicating with the mass of wires that run along the back of the switchboard proper. The board stands about eight feet in height upon a slightly elevated platform. Its total length is 258 feet, and it is divided into forty-three sections, each six feet long.

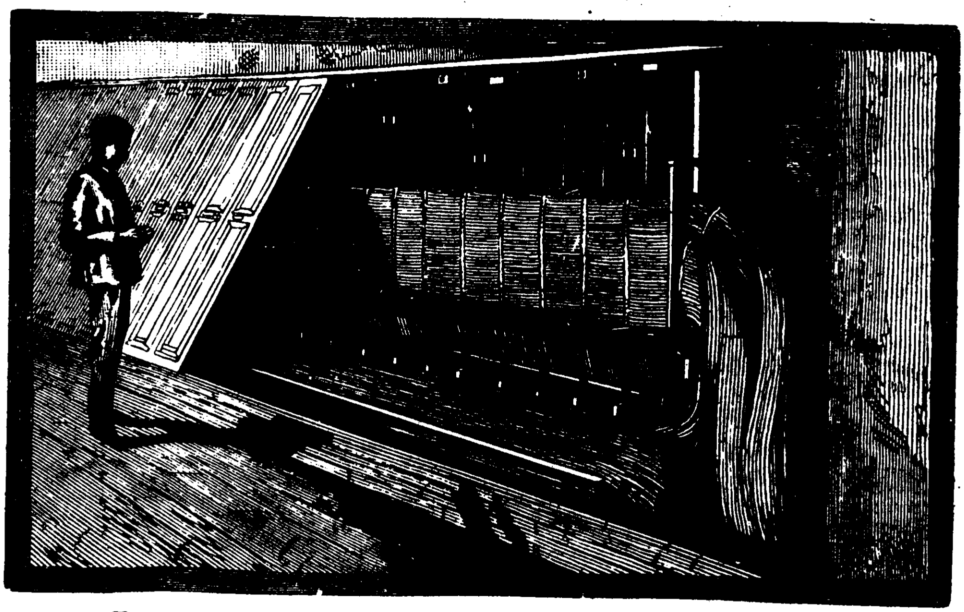


FIG. 3.—REAR VIEW OF SWITCHBOARD, SHOWING CABLES.

The general view of the switchboard (Fig. 4) shows about a third of its length.

Silk-covered wires, cotton wrapped, are used for the board, disposed in cables or bunches, each containing forty-five wires, representing a total of 3000 miles. A view is given (Fig. 3) of the rear of the switchboard showing the groups of cables and also the induction coil boxes and counterpoise weights of the operators' transmitters.

The switchboard which was erected by the Western Electric Mfg. Co. of this city and Chicago, is of the multiple type. It is presumption to set a limit to invention, but the multiple switchboard seems to have nearly reached perfection. At a recent telephone convention in this country it was described as the nearest approach to a perfect system. Its extensive adoption in this and other countries certainly speaks well for its merits. The connections are so arranged that any operator without leaving her place can connect with any subscriber. The converse is not the case. Only a limited number of subscribers can communicate with a given operator. Thus, as the board is now being worked, each operator can be called up by fifty to seventy-five subscribers. But without leaving her place the one operator can put any one of these in communication with any of the 2,500 subscribers now on the board.

Although only this number are now connected, the board is wired for 6,000, with capacity of extension to 10,000 subscribers. It is divided into 43 sections, each section in six divisions. To each division 1,000 subscribers are connected, in groups of 100. Thus each section has connected with it 6,000 subscribers' wires. For each wire a little hole in the front of the board is seen, and back of this is what is called a spring jack. This originally consisted of a pillar about 1½ inches long and as thick as a lead pencil; a simpler mechanical construction has now been adopted. It carries an insulated stud against which an insulated spring presses. In each section there is one spring jack, and there are altogether on the upper face of the board 43 for each subscriber distributed all around the room. Each 6,000 connections are contained within 6 feet of length of board, and this is repeated 43 times. *These connections are for subscribers who are to be called up only.* But the same number have to be provided for in the role of callers. All along the front of the board for its entire length, and near the edge of the projecting shelf or keyboard, is a single row of 6,000 holes beneath which are corresponding spring jacks. This row is 258 feet long; 150 of the spring jacks occupy the lineal space of one section. Back of these holes are annunciators, or drop shutters, one for each connection. The subscribers connect through the annunciator with these spring jacks. For 50 to 75 of these "calling up" connections there is one operator. Arranged in rows parallel with the front of the board there are a number of connecting plugs attached to flexible conductors. For each pair of plugs and cords there are two buttons and an annunciator, or drop shutter. A microphone hangs in front of each operator, and a receiver is held by a spring support against the ear. A hand switch for each calling subscriber is also contained upon the keyboard (Fig. 2). The general operation of making a connection is as follows:

The calling subscriber rings his bell. This produces no corresponding sound in the exchange. It merely causes a shutter to drop, disclosing his number to one of the operators. She at once closes the shutter, inserts a plug in the caller's spring jack, and pulls down the cam lever switch, thus bringing her telephone into shunt circuit with the caller's line, and asks, "What number?" The caller responds, giving, it may be, any of the 6,000 assuming the entire board to be in operation. The other plug of the pair is inserted in the proper spring jack in the upper face of the board, if the subscriber's line is not "busy;" the cam key is thrown up, and one of the buttons is depressed. This rings the bell of the subscriber who is asked for, and the two are now in communication. When through, the subscribers ring their bells. This operates the annunciator belonging to the pair of cords and plugs that is in use for their connection. At one time it may be one pair, and a second time it may be a different pair that is used. The annunciator shutter is seen to drop, the plugs are pulled out, the shutter closed, and all again is in *statu quo.* Before making the connection with the subscriber called for, the operator touches the spring jack frame with the plug. If a click is produced in the operator's telephone, it means that the subscriber is already in connection, or is "busy." If no sound is heard, the line is free.

This use of independent plugs and cords is a recent improvement. For a section of 150 calling-up spring jacks there were formerly 150 pairs of plugs and cords. Now there are only 48, and any pair that is free can be used. For each pair of cords there are a pair of buttons, one for the calling subscriber's bell, the other for the answering subscriber's bell, a cam lever listening key that enables the operator to answer the subscribers, and finally a clearing-out annunciator. In practical work, the operators can be arranged as closely as desired around the board, provided a transmitter and receiver is furnished for each. Thus an operator may be subject to fifty callers or less. But she must be prepared to put this fifty into connection with any of the 6,000 or more on the board.

The wire of a single subscriber may now be traced. It enters the cellar of the building and is carried up to the switchboard and all along its back for its entire length. At each section it is cut, and the ends are connected to its own upper division spring jack, one to the spring and the other to the stud. This is repeated forty-three times. These give the connections for being "called up." Besides these, one connection is made with the proper answering spring jack on the lower row, and thence through the annunciator to earth. Leaving out of consideration the induction coils as unnecessary to the comprehension of the board, the other end of the line may be regarded as grounded at the subscriber's end. Thus the circuit includes the general outdoor and indoor lines, and a line the length of the switchboard with the forty-three upper spring jacks, a single lower spring jack, and a "calling-up" annunciator, also in circuit and eventually grounded.

This circuit is insulated from the frames or front collars of the spring jacks. With these frames, that are nearly flush with the front of the board, a second wire is connected, that for each subscriber simply runs from spring jack to spring jack, for the forty-three main connections all around the switchboard. When a spring jack is plugged, the spring is forced away from the stud so as to break the circuit, and is brought into connection with the plug, and through it and its flexible connecting wire with the other plug and second subscriber, and thus with the ground. But the plugs also connect with the frames of the spring jacks, so that the forty-three frames are all in circuit. The second wire comes here into use. If one of the forty-three spring jacks is plugged, then, the frames of all being connected, if an operator touches any of them with a plug, the click heard in her telephone pronounces the line busy. Unless one of the spring jacks is plugged, there will be no click. This wire, called the testing wire, performs no other function whatever. But it is possible that the entire system may be placed on metallic circuit. Then the second wire wil be utilized as a metallic return. At present there are about fifty metallic circuits in use on the board. The connections in front of the board, showing back and front plugs and flexible connections and counterweights, are shown in diagram (Fig. 6).

In Fig. 4, a general view of the front of the board is given; in Fig. 2, the arrangement of spring jack apertures in groups of 100 is shown. It is evident that the operator can very quickly find any desired number of the 6,000. The upper part of the board is unoccupied. When this portion is filled, the capacity of the board will be nearly doubled. It now, as has been stated, is wired for 6,000 subscribers.

The subscriber's bell is rung by depressing a button. This turns on a current from a dynamo driven by an electric motor. At night a current is taken directly from the storage batteries, and by means of a pole changer is made to vary in direction so as to ring any bell it is connected with.

Some idea of the magnitude of the work may be reached from the number of soldered connections. Of these there are 810,000 back of the board. After it was erected and in place, over a year was consumed in making these joints and connecting the wires with the switchboard.

In Fig. 3 a view is given of the rear of the board showing the general arrangement of cables. The division into sections can here be traced, one section and part of another occupying the foreground of the cut. At the top the induction coils are seen, which form part of the operator's talking and listening apparatus. Hanging from pulleys the counterweights can be seen which support the weight of the swinging transmitting microphones.

On the floor of the room are three desks with spring jack connections, telephones, etc. At each of these sits a monitor, who can connect at will with any of the operators or with her group of subscribers, so as to hear all communications between operators and subscribers. Thus he watches their work, receives from them any notices of faults, and can be asked by the operators for information. The three monitors can also communicate with each other.

Lightning arresters are placed in each circuit back of the board. They are seen in Fig. 4 on the left hand side, arranged in rows against the wall. They consist of a thin strip of easily fusible metal held within a protecting tube. This foil will be melted by the lightning before it can do any injury. Very few are thus destroyed, and can be instantly replaced by new ones.

Starting with front of the keyboard, the following is the succession of keys, etc. (See Fig. 2.) Nearest its front edge is the row of buttons for ringing the calling-up subscriber's bell; second, a row of cam lever switches for the operator's listening connection; third, one set of plugs and flexible connections. There are 48 of each of these in one section. Fourth comes the row of 6,000 answering spring jacks, with, fifth, a correspondingly numbered set of 6,000 calling-up annunciators, 150 to a section. Sixth comes the row of clearing-out annunciators one for each pair of plugs, or 48 to a section; and seventh, the second set of plugs, completing the pair. This completes the contents of the keyboard. Back of it rises the main board, with its quarter million spring jacks, 6000 in a section. The general arrangement may be seen in the diagram of keyboard connections already referred to.

In the rear of the cellar is the lighting plant for supplying current for nearly eight hundred lamps contained in the building, as well as for ringing subscribers' bells. It comprises two Edison and two Electro-Dynamic Co's. dynamos, driven by Buckeye engines. The generators are so arranged that they work in connection with a storage battery, charging it and also supplying lamps with current. At night the battery is relied on for lighting. It comprises 580 cells (Fig. 5) arranged in ten series, giving an output of 300 amperes at about 125 volts potential.

The cells are continually tested with the hydrometer to determine when they are exhausted and when charged, the acid being kept within the limits of 1,160 and 1,200 specific gravity. The voltage of a single cell is never allowed to fall below 1·9. The plant is provided with ammeters and all appliances of the most advanced order.

In a subsequent issue the subject of underground distribution of electric currents for light, telephonic and telegraphic communication, power, etc., will be treated in detail, with full illustrations. The subject of local connections with the through lines and the means of making connections with them will be included, thus fully explaining the solution of underground transmission of electric energy.—*Scientific American.*

"Stone" makes mention of a device for cutting stone by means of steel bands or wire rope made to run around pulleys like a band-saw. Since that time we have been investigating the matter more fully, and are now in possession of full detail drawings and specifications of all that pertains to the apparatus. As soon as translations can be made from matter in hand and cuts prepared, we will give all information extant upon this subject. Primarily, it is well to say that the results contemplated are much more extensive than was suggested in the original articles published by us. Not only stone-cutting but stone-quarrying in all its branches, where cutting is of use, is contemplated. It is intended for horizontal, vertical, or angular cutting. By cutting a channel through the bed of a quarry, horizontal cuttings of any length may be made, subsequent to which the machine may be adjusted for vertical cutting. These may be regulated to any angle. In such cases it is entirely possible to cut vertically any direction into the rock and then horizontally and, if desired, through the top again. While it might not be necessary to do such work at any time, the somewhat fantistic illustrations show us quarry with a central source of power and cords running in all directions, some of which are making vertical, others horizontal cuttings; again, others were transmitting power for the purpose of elevating and conveying stone blocks. Again, there are those which are cutting the quarries into various finished forms. All of the details appear to have been worked out in a thorough and practical way. The means of transmission of power when under cover is by hemp rope, otherwise wire rope. The details of the carriers and tightners are worked out in the most complete manner. Hemp rope as a means of transmitting power under cover is now very generally employed in this country, and has long since been very generally employed in other sections. One of the interesting illustrations of the use of wire rope in cutting is the gangs where large blocks are cut into many parts. The details, while most carefully worked out, are of the simplest character. In the cutting from the quarry the waste is only about one-half of one per cent., and as by its use it is possible to almost entirely do away with blasting or drilling, the general saving is apparent. It is said that the work accomplished is fifteen times greater than possible by old methods.—*Builder and Wood Worker.*

To Remove Finger Rings.—The removal of rings is practiced by jewelers in the following manner:—The swollen finger is wrapped very tightly with a flat rubber braid, commencing at the end; the finger is then held upright for a few minutes, the braid quickly removed, and again wound around it. The operation being repeated three times, leaves the finger so shrunken that the ring may easily be taken off without further inconvenience.

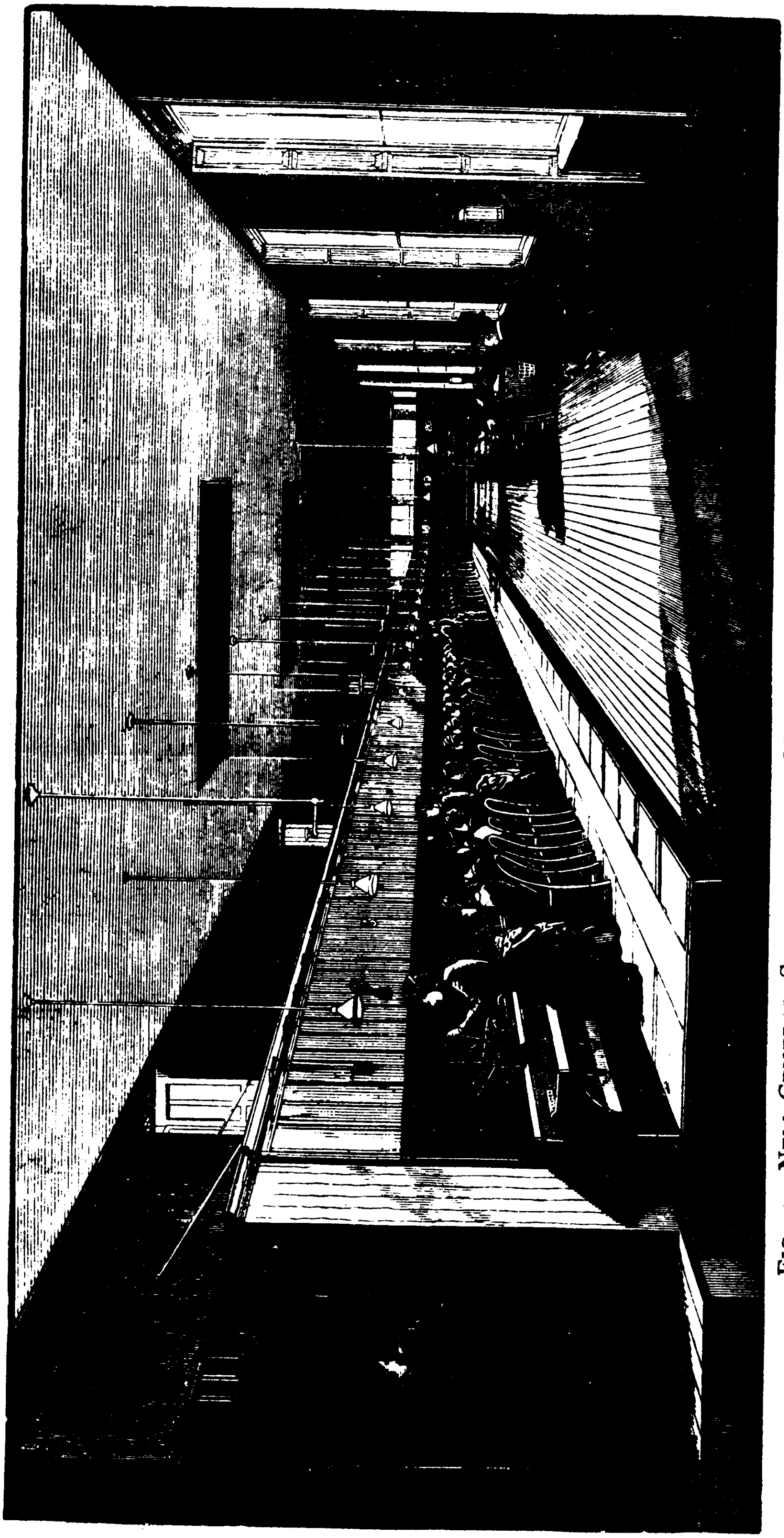


FIG. 4.—NEW CENTRAL STATION OF THE METROPOLITAN TELEPHONE CO., N. Y.
THE GENERAL EXCHANGE.

FIG. 5—STORAGE BATTERY PLANT, SWITCHES, AMPERE METERS AND SWITCHES.

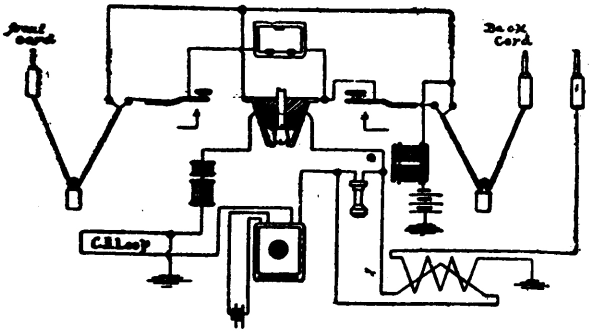


FIG 6.—KEYBOARD CONNECTIONS.

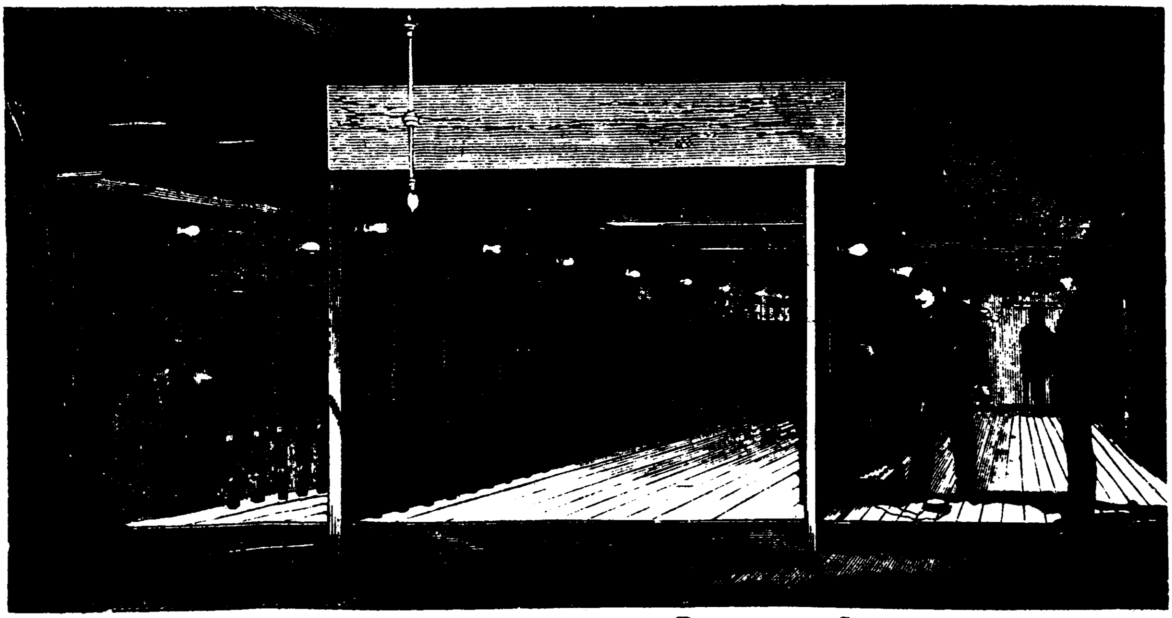


FIG. 7—TESTING ROOM AND CONNECTION BOXES FOR SWITCHBOARD.

PRESENT ASPECT OF INVENTION.

A correspondent has written to us asking whether the realm of invention is not exhausted—whether there is still any chance for one of an inventive mind to devise improvements on existing devices or machines. The doubt implied in the above question seems very natural in view of the record of the patent offices of different countries. Every year sees an increase of patents. Besides these there are numberless inventions that are unregistered and that do not find a place on the records. Notwithstanding all this, the field is so large, and is so imperfectly cultivated, that the work has only commenced. Man's energies now, after so many years of waiting, are bent on the subjugation of the material world. More than half a million patents are the written history of what has been done, but the unwritten portion is the largest. Yet the conquest is far from complete.

If we consider the great inventions that are waited for, perhaps the subject of a prime motor would be the first occurring to the mind. From every point of view the steam engine is unsatisfactory. It is hampered by the condition of a narrow range of temperature, so that with steam of any manageable degree of heat, not more than fifteen or twenty per cent. of the heat of the fuel can possibly be utilized. There is only one way in a heat engine to avoid this restriction. It is to use a very high temperature in the motor. If steam is greatly superheated, it attacks the metal of which a machine is built, it destroys lubricators and packings, and is quite impracticable. Steam cannot overcome the ill effects of the second law of thermodynamics. In the gas engine, in which the combustion of gas is directly used, a higher temperature is obtained, and an engine far more economical in the calorific sense is obtained. But its fuel is expensive, and has to be first manufactured. The cylinder becomes heated, and, to prevent this from going too far, water is caused to circulate around it. This is a concession to the practical, for theoretically the use of water in this place is wrong. Neither the steam engine nor gas engine fills the bill. A prime motor that will convert eighty or ninety per cent. of the heat energy of coal into mechanical energy has yet to be invented.

Another conversion of energy should be the subject of invention. Mechanical energy can be converted into electrical energy with little loss; the problem of a successful conversion of heat energy into the electric form has yet to be solved. The ordinary thermo-electric battery is exceedingly economical, on account of the small difference of temperatures that it can utilize, and, in all of its present forms, must have a low coefficient of restitution. Of all the heat energy which it absorbs, it cannot restore as much even as the steam engine does. A prime motor and a direct converter of heat into electricity, with efficiencies of eighty per cent. or more, and using common fuel, have yet to be invented. In the ordinary cycle, coal is burned under a boiler, and the steam thus generated actuates an engine, in its turn driving a dynamo. In the second conversion of mechanical into electric energy, there is a loss of not over ten or fifteen per cent. But in the first stop eighty-five to ninety per cent. of heat energy is lost. In overcoming this loss, by going directly from heat to electricity, without the wasteful intermediation of steam, there is ample room for invention.

A primary battery that would be economically available for heavy work has yet to be invented. Almost all are characterized by high resistance, expensive depolarizer or a negative plate of high initial cost. In the Upward battery there was a genuinely new departure, but it has not been extensively introduced. The use of zinc for the positive element is a weak point, owing to the expense of such fuel. The storage battery has met with success, in great measure, on account of its low resistance. In the approved arrrangement of primary batteries, one-half the energy is expended uselessly in overcoming the resistance of the battery itself. Several attempts have been made in the direction of advance in primary generator construction, in some cases carbon or some of its compounds being utilized as positive element. In a primary battery of cheap construction, of low resistance, comparable to that of a storage cell, and consuming a cheap positive element, there is a chance for invention of the highest order and economic value.

Even the storage battery is defective. The spurious voltage represents a loss of ten per cent., and its excessive weight and deterioration tell heavily against its more extensive introduction. No one can pretend to say that the climax has been reached in it. The future must have a battery in reserve whose active portions shall bear a more favorable ratio to the weight of the inactive portions.

The field of greater achievements could be gone over and many other wants suggested. The sun's radiant heat should be utilized; tidal force and the movements of the wind should be harnessed and made to do their part in the labors of the world. In considering the great advance of natural science as regards definition only, remembering how accurately the extent of achievement is stated, it is impossible to resist the conclusion that the world is on the verge of the revealment of some of the greatest inventions. To know just what we have done and what are the limits of our power in any given direction, is half the battle, and that half has been won.

In inventions of minor or less fundamental character the field is widening rather than narrowing. Since the days of Faust and Gutenberg, all books have been set up, letter by letter, in the most laborious and primitive way. At last a fairly successful type moulding machine that replaces the compositor has appeared. But no one can pretend to say that it marks the limit of achievement in this particular art. In the most numerous classes of inventions, such as car couplers or lock nuts, there is evidently ample region for work, as certainly the perfect coupler or nut has not yet been invented.

About 1812 Robert Fulton is said to have invented means for bringing the double-ended ferryboats which he had designed to their pontoon docks without a jar. As the ferryboat of the present day reaches her pier, the end of two cables brought from the dock are hooked to eyebolts on her deck, and the cables are then tightened by a species of windlass so as to hold the boat in place. The whole operation is executed by hand, while several hundred people patiently await its completion. In this exceedingly crude contrivance it would seem that a relic of Robert Fulton's invention has been preserved. The ingenuity of the constructors of steamships and railways ought to be adequate to the production of an automatic coupling that would hold the boat in place as she touches the dock.

A good instance of a genuine improvement in a field apparently barren has been afforded during the last few months. The channel eye was one of the first improvements in the needle. By placing the eye near its point, the sewing machine became a possibility. Except for these changes, the latter for a specific purpose, the little pointed piece of steel has remained the same for many generations, and has served as a trial of patience to many of the weaker-sighted mortals who have attempted to thread it. It seemed a hopeless thing to expend ingenuity on. Needle threaders were invented, but proved of little use, and it is within a few months only that a self-threading needle has been placed upon the market.

We think it is evident that the horizon of the inventor's world is widening. Every great change or invention opens a new region, and a fundamental patent is often the basis for numerous and profitable improvements and additions.—*Scientific American*.

QUARRYING BY WIRE CORD.

What the band saw is to the frame saw, so much, and even more, is the continuous helicoidal wire cord to the reciprocating blades now used for sawing stone. Not that it is the blade in one case, or the cord in the other, that cuts the stone, both being merely the vehicles for carrying wet sand, which is the real cutting agent, just as it is in the case of deep grooves worn in iron plates along the towing path of a canal, apparently cut by the tow rope. The network of wires crossing one another in all directions, transmitting power from the engine on the surface to the very depths of the quarry, and in many cases also constituting the cutting tool, has very much the appearance of a telephone installation.

Each cord, about 7-32in. in diameter, consists of three mild steel wires, twisted to the pitch found most suitable in practice ; and this twist imparts a rotary motion to the cord while travelling at the rate of 15 ft. or 16 ft. per second. The cord has its ends joined by a splice 5 ft. long (the ends of the wires breaking joint), so as to be continuous ; and it may be of indefinite length, making several cuts simultaneously, but sufficient space being always left between each to permit of cooling.

The quarry has been worked since 1750, and for the last three years exclusively by wire cord, only thirty hands in summer, and twenty in winter, (all told, including smiths and foreman), being employed for the annual production of the quarry, viz., about 15,000 cubic feet of marble. This does not, however, include the lads who feed the cords down—a practice found preferable to self acting feed, on account of irregularities in the stone. It must be borne in mind that, in quarrying, especially valuable marble, the object is to extract as large a block as possible, and not, as in mining generally, to obtain the largest quantity of product. The sawing by wire cord, with its practically negligible waste, is an enormons improvement over the old system of picking out trenches round all the sides of a block ; and, in the case of sawing a large mass into slabs, the wire cord does in a given time about ten times the amount of work performed by blades.

The process of quarrying by cord will, perhaps, be best described by taking the most unfavourable case—that in which the rock is untouched, having no free vertical side to start from, and which must, of course, occur once in all the beds into which stratified rocks are divided, or at each successive height of working in unstratified rocks. After the surface has been laid bare, it is necessary to sink at least three shafts, of 2 ft. 6 in. in diameter, to the natural parting, or desired depth of block, in order to introduce the pulley carriers for bringing the wire cord into play. At first, these shafts were sunk at the Traigneaux Quarry by hand labour with the pick or hammer and chisel, but now they are sunk entirely by mechanical means.

The constructor of the wire cord apparatus, M. Thonar, of Namur, has devised a perforator or trepanner, which makes an annular cut, like the diamond drill, leaving a core in the middle. It consists of a hollow cylinder of boiler plate, about 12 ft. high by 1 ft. 8 in. in diameter, shod at the bottom with an annular serrated steel cutter slightly thicker than the plate, so as to give the necessary clearance. The drill is mounted in a frame consisting of three uprights, and is made to revolve directly, at a speed of about 140 revolutions a minute, by a teledynamic cable working in a grooved pulley keyed on to the shaft. The power required is about 3½ h.p. for a descent of 1 in. per hour in marble. If the drill should become clogged, it is readily lifted out of the hole by a winch, which forms part of the apparatus. Sand and water are allowed to flow inside the perforator, and find their way down the clearance between it and the stone, through small holes in the cutter, rising to the surface again between the perforator and the rock. So greatly does the sand supplement the action of the teeth, that recently the cutter has been superseded by a plain collar of soft iron, with excellent cutting results and saving in first cost, besides having no teeth to sharpen. In the case of very hard rocks, the collar has been set with particles of emery amalgamated with metal—of which more hereafter— in the same manner that the crown of the diamond drill is set with "borts" or "carbonates." With a perforator 1 ft. 8 in. in diameter, it is necessary to sink three contiguous shafts and break down the intervening angles, in order to obtain the requisite space for the pulley carriers. This is not, however, "dead" work, as the cores are used as columns ; and the diameter of the drill may be reduced to the size of columns most in demand, provided their number be correspondingly increased so as to obtain sufficient space. Let it be supposed that two shafts of a minimum diameter of 2 ft. 6 in. have been sunk by one method or another to receive the pulley carriers. Each of these latter consists of two uprights, carrying between them an upper and a lower grooved pulley, both normally in the same vertical plane ; but the axis of the former is set out, and that of the latter is set in, with reference to the uprights, so as to give the necessary direction to the running wire cord. Moreover, the upper pulleys are capable of a slight horizontal travel, while the bearings of the lower ones slide in guides between the uprights, and are fed downwards by an endless screw, motion to which may be given automatically or by hand, as stated above. A pulley carrier being inserted in each of the two shafts, the cord is passed round the pulleys and set in motion, a suitable tension being maintained, as described below, and sharp sand and water being allowed to flow into the cut.

The writer observed, at the Traigneaux Quarry, the cut deepened to the extent of 4 in. per hour in a block of marble 8 ft. long, and was assured by the managing director that he had by this method cut Belgian porphyry and hard Bavarian granite blocks of about the same length at the rate of 1 in. per hour. At the Brussels Exhibition of last year, where the Société Anonyme Internationale du Fil Héliçoïdal had a complete installation, for which the first prize of progress was awarded by the International jury, still harder work was done. On this occasion, the same cord that cut a block of marble also cut a turret of concrete, composed of quartz pebbles from the bed of the Meuse.

To extract a triangular block of such size that it can be lifted by crane, one more shaft and two more cuts only are necessary ; but if it be desired to extract a parallelopiped, four more shafts —six in all—must be sunk, and five vertical sides of the mass, but also to afford a 2 ft. space along one side for clearance. This 2 ft. space may be taken out by the pick if the stone should happen not to be very valuable, or the block may be lifted out by cranes. The spaces thus produced affords sufficient clearance for canting the mass over by means of wedges, crowbars, screwjacks, and winches or cranes. This is under the supposition that the rock has a natural bed or parting, down to which the saw cuts are carried ; but in the case of an unstratified rock there is no alternative but to blast or pick out the clearance space, and run a nearly horizontal cut by wire cord under the mass to be extracted, while maintaining it in position by wedges, in order to prevent any pressure upon the cord. The cut is sufficiently inclined from the horizontal to permit of the sand and water flowing to the cord ; and, in this case, the grooved pulleys are turned on their universal joints so as to be horizontal; but such a cut is rarely required.

Blocks up to 25 tons are hauled up the incline of one in seven from the bottom of the quarry to the surface by means of a three-speeded winch, driven by the 30-horse power engine, which provides the whole motive power. They are then, if desired, further sub-divided, or sawn into slabs, always by wire cord; but the diameter of the cord decreases, while its speed increases, inversely with the length of cut. The diameter of cord for sawing a block into slabs is 5-32 in., and several cuts are made simultaneously. In this case the cords are passed over pairs of grooved pulleys, adjustable on their axis, the tension of each cord being independent of the other, on account of possible inequalities of hardness in the stone. The cords are in all cases kept at a proper tension by a weighted truck on an incline.

While the sub-division of a large mass at the bottom of the quarry requires generally 2-horse power, a frame of ten wires for sawing a block into slabs absorbs from 4-horse power to 5-horse power. A cord 100 to 300 yards long will, on an average, make a depth of 69 ft. to 15 ft. cuts, or produce 487 square feet of sawn surface, before wearing too smooth to carry along the sand. It will then have become reduced to nearly the diameter of one of the wires originally composing it, and may be used for various other purposes, such as fencing.

Marble slabs, sawn by the ordinary blades, have a tolerably smooth surface, owing to considerable attrition by the sand adhering to the sides of the blades; but this is of little advantage, as such slabs are rarely true, so that the finish is generally removed in the process of trueing. On the other hand, slabs sawn by wire cord are quite true, but not so smooth as the others. The surface is true because the cords are kept at a considerable tension; but it is not smooth because the cord sways a little vertically, producing a succession of grooves like the "traverse marks" in an iron surface produced by the successive cuts in a planing machine. The absence of smoothness is, however, a small matter, because any amount of finish is readily put on by a machine like that used for polishing plate glass, in which a flat head is made to travel all over the surface while at the same time revolving. In the stone polishing machine the head is made to revolve at a very rapid rate, the speed not being limited by the centrifugal tendency of any polishing powder, while a third motion is given by making the carriage travel backwards and forwards automatically. The polishing medium consists of emery and metal amalgams suitably prepared—emery and iron being used for marble. By uniting the emery with various metals in fusion, advantage is taken of the efficient polishing power of the former substance, while the difficulty of using it in the natural state or in powder is removed.—*Industries.*

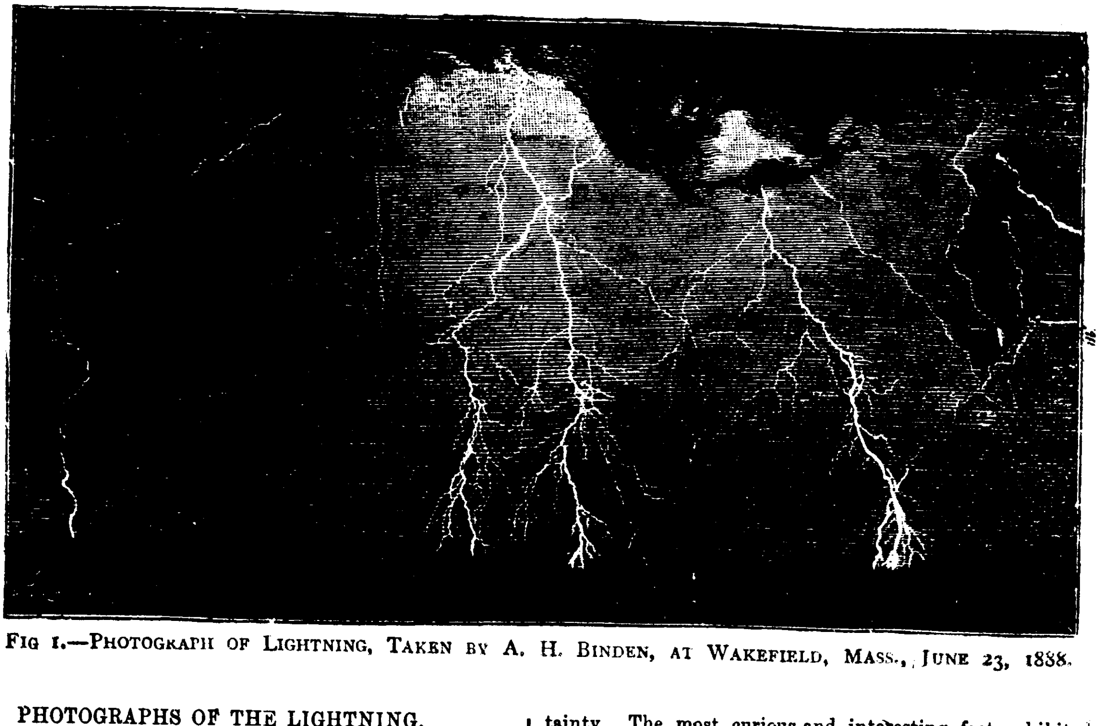


FIG I.—PHOTOGRAPH OF LIGHTNING, TAKEN BY A. H. BINDEN, AT WAKEFIELD, MASS., JUNE 23, 1888.

PHOTOGRAPHS OF THE LIGHTNING.

One of the most interesting applications of photography since the production of plates of extraordinary sensitiveness has become possible, is shown in the remarkable pictures accompanying this article. No more convincing proof of the wonderful advance made of late years in the production of light-sensitive pictures could be imagined than is afforded by the fact that they are capable of catching and retaining the evanescent lightning-flash, the duration of which is such an infinitesimally-minute fraction of time that the most refined instruments of precision are unable to determine it with certainty. The most curious and interesting fact exhibited by the photographs of the lightning, is that the flash which to the human eye exhibits the appearance of a single forked or zigzag line of light, records itself on the infinitely more sensitive photographic plate as quite destitute of the forked or zigzag characteristic, and is divided by innumerable ramifications, proving that the stereotyped mode of indicating the appearance of a lightning flash by a sharply angular series of deviations, is erroneous. This fact was first noticed by W. N. Jennings, of Philadelphia, one of the earliest and most successful experimenters in this direction—as early as the year

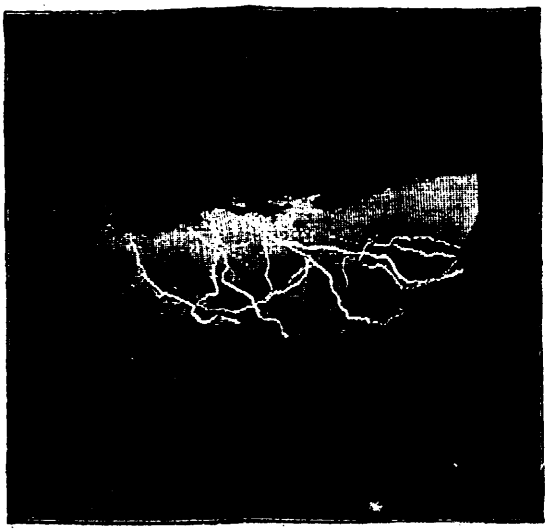


FIG. 2.—PHOTOGRAPH OF LIGHTNING, TAKEN IN PARIS, JULY 22, 1888, BY FELIX BURLE.

1883; and his observation has been repeatedly confirmed by subsequent experimenters.

The two lightning pictures shown herewith, and which are reproduced from photographs, exhibit the total absence of the zigzag character most convincingly. We have had the opportunity of examining perhaps a score of similar pictures of the same character, and in none of them does the zigzag appearance exhibit itself. The photographic plate records immeasurably more minute details than it is possible for the human eye to take cognizance of in the infinitesimal fraction of time of its duration, but invariably records it as a wavy line, with more or less abundant branches and ramifications of the same character.

The picture shown in Fig. 1 is, perhaps, the most remarkable lightning photograph yet secured. It was taken by A. H. Binden, at Wakefield, Mass., on Saturday, June 23rd, 1888, between 8 and 9 o'clock in the evening, during the occurrence of a thunder-storm.

The other picture (Fig. 2), which is scarcely less remarkable, is reproduced from a photograph obtained in Paris during a storm, on Sunday, July 22nd, 1888, at 10 o'clock at night. It was taken by Felix Burle.—*Manufacturer and Builder.*

ISOTHERMAL WELLS;

OR, HOW TO OBTAIN COOL DRINKING WATER WITHOUT THE USE OF ICE.

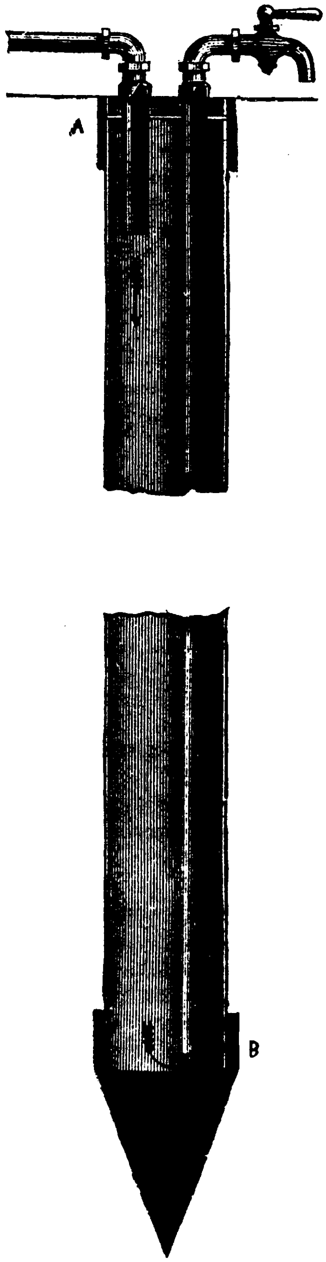
BY HENRY D. PLIMSOLL.

During several years, it was the good fortune of the writer to visit the home of a friend whose residence was some few miles distant from New York, and it was his custom when there, to rise early for a stroll before breakfast, and also to draw for himself a draught of refreshingly-cool water from a near-by well.

On one occasion, however, in the winter, when the thermometer indicated a temperature near zero, instead of the "nineties," as on previous occasions, he stopped to take a draught, and found the water by comparison almost warm. For a moment he was puzzled, until he reflected that he was face to face with one of those phenomena of nature of which previously he had merely read in his studies; in other words, that there was not any change in the temperature of the water, as between summer and winter, but in the air by which he was surrounded.

This uniformity of the temperature of the water below the surface of the earth is known as "isothermal" (equal heat), and may be more properly described as follows: In latitude 40 degrees, the isothermal line is at a distance from the earth's surface, varying from 40 to 60 feet, and along this line the temperature is about 50 degrees summer and winter. Below this line the temperature rises 1 degree for about 50 feet in depth. At twenty feet below the earth's surface, the average summer temperature varies from 10 to 15 degrees lower than the average summer temperature of the surface.

During the past summer, the writer visited a friend whose residence was also a few miles outside the limits of the city, and the conversation, turning upon the former luxuries that,



ISOTHERMAL WELL.

from persistent use, have become the necessities of our civilization, the host said: "I can dispense with ice," and, leading the way to a well, began to haul at a rope, when soon there rose to the surface a tray on which were supplies of butter, meat, and other provisions that it was desirable to keep at a low temperature.

This was a practical use of the isothermal phenomenon, which the writer thinks would be more widely adopted if it were more widely known, and he would suggest the construction of isothermal wells, as per accompanying cut, to those who have the misfortune to be supplied with water that previously has been allowed to acquire a high temperature from exposure to the sun in our American city reservoirs.

Briefly described, it is a pipe closed at the bottom, and driven into the ground. The water from the reservoir is let into it at the top A, but before being drawn off at the faucet D, must have passed down to the bottom of the pipe B, in order to ascend the smaller pipe C, and, during this descent, it will have a tendency to acquire the temperature surrounding the lower part of the pipe—*i.e.*, the well.

There are reasons why the pipe B, should not be larger than 2 inches in diameter, and they may be briefly stated as follows: First, iron pipe, in the process of manufacture, increases largely in cost with the increase of diameter. Secondly, iron pipe, properly pointed, may be driven by hand when only 2 inches in diameter; but if the size be larger, say 3 inches, it is apt to be destroyed by the force of the mallet, and above 3 inches in diameter it can only be sunk into the ground by the aid of suitable boring machinery. Thirdly, the volume of water in the pipe increases much more largely with the increase of the diameter of the pipe, than the increase of surface for the radiation of the heat; for instance, a 2 inch pipe, having 6 inches of circumference for radiation, contains only .1632 gallons of water per foot to be cooled, while a 3 inch pipe, having only 9 inches of circumference, contains .3672 gallons of water per foot.

A 2 inch isothermal well, while comparatively inexpensive, will supply a sufficient quantity of cool drinking water for any ordinary household, and pay for itself in the economy of ice.

Further, the writer thinks that this isothermal phenomenon might be used to great advantage if pits of large diameter, and with sides of masonry, were sunk in the basements of dwelling-houses for the storage of provisions; for not alone would the provisions be kept at a low temperature, but, that commingling of flavors, which is apt to take place in food products, when a variety is confined in the close limits of an ordinary household refrigerator, would not occur.—*Manufacturer and Builder.*

THE PRESERVATION OF TIMBER.

The question of timber preservation is one of national importance, and as it is the aim of this journal to keep its readers informed in regard to everything connected with the timber interest, we do not think we need apologise for devoting considerable space to an account of the causes of the short life of timber used by railways, together with a description of some of the methods for its preservation.

There are two principal causes for the destruction of timber in use by railways, namely, decay and mechanical wear. When wood is exposed to the atmosphere its decay may be considered a species of fermentation set up by the combined action of heat and moisture in the watery and albuminous constituents of the wood, which gradually convert it into "humas" or rotten wood, this process being at the same time expedited by the presence of numerous boring insects, which take up their abode in the cells of the decaying wood, and feed upon its juice.

The object of any rational treatment for preserving wood is the coagulation of the albumen by substances capable of effecting this; of these the most effectual, as well as the most practical on account of its low cost, is creosote, which exercises a powerful action in the coagulation of the albumen, and is also so destructive to all kinds of insect life as to completely exclude them from any wood which has been treated with it; the presence of a sufficient quantity of creosote in any liquid at once, and completely destroying all germs of animal or vegetable life.

Of the substances containing creosote, the two most important, and in fact the only ones available for this purpose, are coal tar and wood tar. When coal tar is distilled in iron vessels there is produced, in addition to other substances as naphtha, etc., about 30 per cent. of the so-called creosote, or dead oil, which has, since 1850, been used in continually increasing quantities for this purpose.

The quantity of coal used for gas-making in Europe is about 10,000,000 tons annually, producing about 5 per cent. of tar, yielding about 150,000 tons of dead oil, the whole of which is available for treating timber. There is also a very large quantity of coal tar, produced as a by product of the gas manufacture in the United States; but, except in a few cases, nothing has been done towards utilising the dead oil contained in it.

The second substance, wood tar, referred to above, is the tar produced by the destructive distillation of wood for the manufacture of charcoal; considerable quantities of this substance are produced, but as yet it has only been considered a waste substance or available for fuel.

As wood tar contains a large percentage of true creosote, which is entirely absent in the case of coal tar, it is a better preservative of timber than any of the constituents of coal tar, and recent experiments have demonstrated that it may be used by itself for this purpose, if forced into the cells of the timber while heated and in a fluid state. Many other substances have been proposed for treating timber, but on account of their cost and the comparatively small quantities produced are not available to any important extent for this purpose.

The method of treatment which is generally considered to be the most thorough, practical, and rational, is that which involves first the subjection of the timber in close vessels to the action of high pressure steam, for a sufficient length of time to enable the steam to penetrate all the cells of the wood, and to vaporise the liquid contained therein, these being afterwards removed by a vacuum pump

After this preparatory treatment, the preserving substance is forced into the cells of the wood under powerful pressure, the quantity of this substance being regulated according to the use for which the timber is destined. If simply to be used for bridges or elevated structures, the quantity of preserving substance is less than for the ties, and if for use under water or exposed to the attacks of the teredo the largest amount which can be forced into the wood becomes necessary.

The apparatus needed for treating timber by this method is simple and comparatively inexpensive. It consists of a cylinder of boiler plate, the size of which depends upon the dimensions of the timber to be treated. This cylinder is made strong enough to resist a pressure of 300 lbs. per square inch, and has a track extending for its whole length along the bottom, the ends of the cylinders being closed by strong iron doors, provided with suitable means of rendering them air and watertight. Iron cars having wheels of small diameter fitting the track on the bottom, the end of the cylinder being closed by strong iron doors, are provided to carry the timber or ties while under treatment. A steam boiler with a vacuum and force pumps, and reservoirs fitted with steam coils, for containing and heating the preservative substance, are also provided. The operation may be briefly described as follows:

After the cars loaded with timber for treatment are run into the cylinder, and the doors closed, steam at about 100 lbs. pressure is injected into the cylinder, and the supply continued for a length of time, depending upon the nature of the wood and its dryness. The steam is then shut off, and the vacuum pump started, and kept at work as long as any liquids or vapours are obtained. The vacuum pumps are then stopped, and the hot preserving liquid allowed to flow from the reservoir into the cylinder until it is filled. After this the force pumps are started, and their action maintained until the pressure in the interior of the cylinder rises to about 100 lbs. per square inch, the pressure being maintained at this point until a sufficient quantity of creosote oil or other preservative liquid is forced into the cells of the wood. The force pumps are then shut off, and the creosote oil or other liquid contained in the cylinder discharged into a suitable cistern, after which the doors at the ends of the cylinder are opened and the car carrying the timber or ties run out.

When wood has been creosoted in the manner described, paying proper attention to the complete removal of water and juices previous to the injection of the creosote, the density of the wood will be found to have considerably increased, and that its tenacity for holding spikes, etc., as well as its ability to resist mechanical wear, has also increased to a noticeable extent.

The principal item in the cost of preserving is the quantity and the cost of preserving substance. In the case of ties, three gallons of dead oil or of wood tar will be required, while for bridge timbers a smaller quantity will suffice.

The cost of treatment, aside from the cost of the preserving agent, will not in the case of ties vary much from 5 cents. per tie. The cost of dead oil ranges from 7 to 10 cents. per gallon.

Ties for creosoting should be carefully selected, as it is manifestly poor economy to creosote a tie in which decay has already commenced.

The necessity of a most thorough preliminary treatment of the ties for the removal of fermentable substances cannot be too strongly insisted upon, as the value of the subsequent preserving process depends almost wholly upon its proper performance, and its neglect has been the cause of frequent failures in wood preserving operations.

Complaints have been made that creosoted beech wood ties become rotten in the middle of the tie, while the outside for an inch or two in depth remained perfectly sound. The reason for this condition of the tie seems clearly traceable to the neglect of a proper preliminary treatment of the tie; water and juice had been removed from the surface of the tie, but not from the interior. Consequently, the creosote oil was unable to penetrate that portion of the tie on account of the cells being already filled with water.

We do not wish to be understood in this article as advocating the immediate adoption in all cases of wood preserving processes, for this will depend largely upon the cost of the ties. In many localities their cost is still so low as to preclude any treatment of this kind, but there are many others in which their cost has already increased beyond the point where creosoting may be profitably employed; the area of such localities is continually increasing, and it needs no prophetic vision to foresee that in the near future the adoption of some preservative process for wood will become universal.—*Builders' Reporter and Engineering Times.*

HOW COMMON CIRCULAR SAWS ARE MADE.

Ordinary circular saws are of all sizes, from six inches to six feet in diameter. The plates from which they are shaped come from steel-mills in circular form, almost round, if not perfectly so. The first thing to be done is to see that each plate is made a perfect circle. A hole is then cut in the centre, and the teeth are marked around the rim. The plate is then taken to a machine on which the teeth are to be cut. It is placed upon a pin at such a distance from the machine that the edge becomes beneath the die, and the operation of teeth-cutting begins. The steel is cut cold, each tooth being made by one blow. All sizes and descriptions of dies are necessary, as the style of saw and saw-teeth are many. After the teeth have been cut the next operation is that of tempering, which is the most difficult and important process in the making of a saw. Several saws are placed in the furnace at a time, and allowed to remain until they have reached the proper temperature, a light cherry red, when the plates must be taken from the oven and plunged into a vat of whale oil, heated by pieces of red-hot iron or steel, which are placed in the vat one after another until its contents are properly heated. As each piece is dropped in, a brilliant flame leaps from the surface of the oil and continues to burn until extinguished by stirring the liquid with a long iron rod. The large, glowing plates are then cautiously slid into the vat. Leaving the tempering department, the saw goes back to the main shop to be hammered and straightened ready for grinding. This work is done by hand. After the plate, which has been more or less warped in the tempering process, has been made perfectly straight again, it is placed in the grinding machine, which is a carriage between two wheels, which turn it, and at the same time press its sides against a rapidly revolving grindstone. The carriage is fixed in automatic bearings, and is moved back and forth at the will of the operator. It usually takes about two hours to grind a large five-foot circular saw, though the time varies according to the kind of saw that is being made. The next operation is that of polishing, which is done with emery-wheels. To polish a large circular saw the plate is secured to a large wheel or flange, which turns, carrying the saw with it, the workman meanwhile pressing an emery ball (attached to a handle) against the side.

The saw must then be "rounded," that is, care must be taken to prevent one tooth projecting farther than the others. For this purpose the saw is placed in a bearing and made to turn slowly. It is then gradually brought in contact with an emery-wheel, the latter turning very swiftly, until the edge of every tooth touches the wheel. The saw is next sharpened and submitted to further hammering for the purpose of "truing" and straightening, and is then cased ready for shipment.

One important part of the sawmaker's business is the renovation of old saws injured in fires. It is straightened up, tempered over again, and provided with a new set of teeth.

This article has dealt only with common circular saws, the teeth of which are not separate from the plate. Other saws, however, supplied with inserted teeth of various kinds, are made in large numbers. These are all patent saws, and can be supplied with new sets of false teeth as often as necessary. —*Mining and Scientific Press.*

THE TRAINING OF ARCHITECTS.

At a recent meeting of the Philosophical Society of Glasgow, Mr. Henry Dyer, C.E., read a paper on "The Training of Architects," and referred to the subject chiefly from a scientific and engineering point of view—thus supplementing a paper which had been read by Mr. Newbery, the head master of the Glasgow School of Art, during the previous session, on the artistic side of the training required by architects. As we think that hitherto architects have been almost entirely artists, and, consequently, unable to deal with many of the scientific questions arising in the course of their practice, we will shortly mention a few of the points raised by Mr. Dyer. He commenced by insisting that the first duty of an architect was to make his building suitable for the purposes for which it is intended, and having done that, then to make it as beautiful as circumstances will admit, and he supported his position by quoting the opinion of Sir Gilbert Scott to the following effect: "Architecture differs from her sister arts of painting and sculpture in this—that while they directly originate in a sense of beauty, and are either wholly independent of utility, or only accidentally connected with it, architecture results in the first instance from necessity, beauty being a superadded grace. The element of beauty may increase in its relative importance with the nature and objects of the building in proportion as the building becomes more monumental in its character; but in no class of building can beauty consistently be allowed to interfere in any degree with the efficiency with which the structure provides for and carries out the primary object of its erection, whatever that may chance to be. No class of building is so completely the result of necessity as our houses—our existence is dependent upon them, and health, comfort, and convenience require that they should be constructed with all possible regard to the demands of our nature and the customs and necessities of the state of society in which we are placed. We may superadd taste to any extent, but if it interferes with any of these primary requirements it (just so far) defeats the objects for which domestic buildings are erected, and becomes a nuisance instead of a luxury. It follows that no style of architecture is good for anything which demands that utility should in any degree be sacrificed to taste. It has consequently been in all ages the aim of good architecture not only to add beauty to utility, but as far as possible to make it grow out of and result from the uses and construction of the various parts of the building—an object which becomes doubly urgent in those buildings on which our life, health, happiness, and convenience are in so great a degree dependent."

After illustrating some of the shortcomings of architects in the construction of buildings, Mr. Dyer proceeded to show that if architects would confine their work to the province assigned to it by Ruskin, that is, to "so dispose and adorn the edifices raised by man, for whatsoever uses, that the sight of them contributes to his mental health, power, and pleasure," they would make their profession a very limited one indeed, as it was impossible to draw a strict line between architecture and building construction. Moreover, as the majority of structures are intended to be lived in, either as places of residence or of occasional meetings, and if they are so arranged that bodily health suffers, mental health, power, and pleasure are not likely to be in good condition. While admitting the artistic side of architects' training should always predominate, Mr. Dyer, pointed out that the scientific or constructive should receive more attention than has hitherto been the case. Architects should know sufficient mathematics to enable them to understand the principles of construction of such buildings as fall within the range of ordinary practice. There is no necessity for much of their time being taken up with this part of the course. What is required is a clear perception of the general principles, rather than an intimate acquaintance with details of methods, as a little practice and the study of standard works would soon enable them to design sufficiently exactly, without requiring to go into elaborate calculations. They should have a fairly good acquaintance with physics, at least with those parts which are connected with the acoustics, lighting, heating, and sanitary arrangements of buildings. There are few public buildings in which a speaker can address a large audience with any degree of comfort to himself or his audience, and fewer still in which the arrangements for ventilation are even passably good. The subject of protection from fire should receive more attention than it does at present. Many buildings are little better than match boxes, and even in those in which special precautions have been taken we very often find some defect in construction or arrangement which practically nullifies all these precautions.

Although the object of Mr. Dyer's paper was not to take up the art, but rather the engineering or scientific side of the training required by architects, he pointed out that more attention should be paid to some of the relations of architecture to the sister arts of painting and sculpture, and dwelt on the necessity for there being more sympathy between the architects, the painters, and the sculptors. These preliminary observations led up to the main purpose of the paper, which was the development of a scheme of education specially suited to the circumstances of Glasgow, but which, with a few slight modifications, would do as well for any other locality. Mr. Dyer pointed out that it is highly necessary in architecture, as in every other profession, that the students should first of all receive as liberal an education as possible, not only in general subjects, but also in those branches of science which are necessary as a foundation for their scientific training. In the Glasgow and West of Scotland Technical College, in conjunction with the School of Art, complete courses of study, both in the art and science of architecture, have been arranged, and no doubt many young architects will find these sufficient for their wants, as they cover pretty well the ground gone over in the examinations of the Royal Institute of British Architects. Mr. Dyer proposes that a suggestion which was made by Professor Roger Smith at the conference which was held under the auspices of the Royal Institute of British Architects about two years ago, should be carried out, and what he calls an architectural studio or drawing office be instituted in connection with the college, in which students would get a very good introduction to the practice of their profession. The work done would consist of lectures on the different departments of architecture, and designs in illustration of these, supplemented by such practical work as is to be picked up by architectural students regarding specifications, estimates, quantities, &c. The students are supposed to enter on this course of study, which extends over three years, when they are 16 years of age; and Mr. Dyer suggests that those who complete the course, and receive the diploma of the college, should only be required to a three instead of a five years' apprenticeship. On the other hand, he suggests that those evening class students who complete the advanced course of study should serve four years, the junior course being the minimum which is compulsory on all students. Such arrangements would be sufficient to meet the wants, capacities, and opportunities of the different classes of students. Mr. Dyer is of opinion that all proposals in education should have for a crown a University degree, and arrangements are now being made for connecting the Technical

College with the University, so that its classes may be recognised for a great part of what is necessary for a degree. But whatever is done in this matter, Mr. Dyer thinks that the architects of Glasgow should not rest content until they have a Professor of Architecture in the University—a man of wide culture and experience, who would imbue architects with proper ideas of the dignity of their profession, and lead public opinion in such a way as to insure that opportunities were afforded for the most thorough training being obtained by those who were really able to take advantage of it. Mr. Dyer concluded by advising the architects not to increase the number of examinations unnecessarily. If they were properly represented on the examining boards of the different teaching institutions, the certificates or diplomas of those should be accepted by the professional institutes. The tendency of the present day is to multiply examinations to such an extent as to stifle all originality both on the part of the teachers and the students, and to turn out the latter, loaded with certificates, but with all true scientific and artistic spirit extinguished; and he trusted that arrangements would be made which would induce the students to study the art and science of their profession in such a way as will not only make them good architects, but also, what is of more importance, good men generally.—*Industries.*

BUILDING AND PLUMBING.

In our large cities complaints are general regarding the sanitary condition of some quarters of the cities, public buildings, and private residences. These complaints are indicative and suggestive. They indicate that there is a healthful agitation of sanitary matters, and suggest that the evils will be remedied, in many instances pointing out the cause of the evil, and recommending its cure. There is probably no subject that has been studied and discussed more of late years than the evils arising from imperfect house drainage, and, as related to man's well-being, there is no subject of more importance.

Of late years the subject has received attention from our best scientists, and on it has been bestowed the efforts of our most advanced sanitarians. Yet there is regarding it a serious indifference or ignorance which permits the construction of unhealthy buildings in the midst of our most aggressive sanitary intelligence. No one will deny that ignorance of these important matters exists to a surprising extent. It must be admitted that architects, plumbers, builders, etc., are intelligent and generally abreast with hygienic knowledge; yet these complaints evidenced a lack of intelligence or care somewhere. There is really a lack of both; the owner of the building erected is ignorant of sanitary laws, and the officers whose duty it is to enforce them are often too indifferent, unable or incompetent. It can hardly be presumed that the proprietor would have a house erected in violation of the laws of health if he knew them, and in the majority of cases he has his building constructed as he wishes. To him must be attributed the ignorance. To the officers whose duty it is to enforce the sanitary regulations provided by municipal or State government, ascribed the indifference.

A case in point is found in an article by D. D. Kearns in the St. Louis *Republic*: "At present in our city of 63 square miles we have two plumbing inspectors, and, indeed, to be more exact, we have but one who personally inspects our houses. That this one man can properly do the work for which he is appointed would be absurd to expect, no matter how strict our laws might be. At present when a man wishes to build a house he visits his architect and gets his plans executed and figured on. Then it becomes necessary to procure permits from the Building Inspector's office and from the Sewer Inspector. Thus we find two different departments which should be combined in one, and which would without doubt give better results if so managed."

Boston is pointed out as a model for its building and plumbing laws. These laws are not only very perfect, but the machinery for their execution is adequate, and is presided over by intelligence. The Building Inspector's office is efficiently provided and is conducted with business regularity and care. Under a chief inspector are appointed careful men, well versed in building matters, often chosen from the ranks of mechanics. These men are given a certain district, and are expected to note all the work going on in that district and report progress day by day. The laws governing the work being well understood and very stringent, it entails but little work to see that they are obeyed. Thus, not only is the inspector expected to know all about the new buildings in his district, but by inspections he becomes familiar with all kinds of houses, and often is the means of saving valuable property in cases of fire by reason of this outside knowledge.

The evils of improper methods in building and plumbing cannot be laid to the charge of builders, architects, or plumbers wholly, even should they be inclined or induced to disregard sanitary laws. It is the business of the inspector to secure regard for those laws—to enforce their observance on the part of the artisans and contractor, and to prevent the error of ignorance on the part of the proprietor. Yet behind the inspector are the laws and the agencies through which they are administered. In many cases the laws are insufficient. They are not broad enough in scope or minute enough in detail. Many health departments are of recent establishment, and the laws provided for them have not been properly adjusted to the existing conditions. Departments that have been longer established have not received the legislation necessary to meet new conditions and the general growth. Moreover, courts are tardy and lax in the proper enforcement of existing laws, and in many cases do not give the subject of sanitation the serious thought its importance demands.

Hygienic knowledge is becoming more perfect, practical, and general, and sanitary intelligence has been reduced to a practical science for every-day use. Our plumbers are intelligent, and it is not reasonable to suppose that they would slight their work when so much competition exists. It is to their interest to do good work, for each job is an advertisement of the character of the work performed. They are often called on by the owner to do work in a certain way. Inspection permits this, and unhealthy shops, stores, business offices, and homes result. Enough of this is seen in our cities to call loudly for a reform—a better enforcement of law. The teaching of the sanitarian stops short of this. It is busy in keeping pace with new conditions arising from the demand for greater building and the complications of inventive necessity. The agencies of the law are sometimes slow to adjust themselves to new relations, and in this they fall behind the spirit of progressive sanitation. No plumber, architect, or builder would oppose the proper regulation of these matters, for a perfect building is their greatest pride. Our officials must become more strongly impressed with the importance of their duties and more prompt, efficient, and thorough in their discharge.—*Sanitary News* (Chicago).

The following is a very good stain for ash: Dissolve 4 oz. shellac, with 2 oz. of borax, in ½ gallon of water. Boil until a perfect solution is obtained, then add ½ oz. glycerine, after which add in sufficient water, soluble aniline black, and the mixture is ready for use.

PHOTOGRAPHIC NOTES.

Plates for Development with Plain Water.—Mr. Leo Backelandt, a well known Belgian chemist, has just issued plates covered on the back with salts fit for the development of the image. It suffices to immerse the plate in ordinary water, and this immersion dissolves the reducing salts, and the image is developed. It is a very ingenious idea. We have just made a successful trial of these plates, and we think that they will be appreciated by amateurs desirous of dispensing with the trouble of preparing developing solutions beforehand. The fixing agent, ready powdered, is also inclosed in the box containing the plates; so that we have at once the sensitive film, the developer, and the fixing salt all to hand in the solid form. If the thing is really as good as it appears to be at first sight, what facility is offered for photographing on a journey in the country, etc. We think that by the help of papers impregnated with developing salts the same result may be obtained, and then this method will be applicable to plates, papers, and pellicles of all makes.—*Leon Vidal, in Photo. News.*

Rapid Hydroquinone Developers.—A point of great importance is stated by Captain Himly, and his statement concurs with what has reached us from other quarters, namely, that the addition of a small quantity of caustic alkali to either the carbonate of potash or soda developers confers more brilliancy and more detail upon the negative, advantages independent of that for which it was added—its great accelerating influence. This is a very curious and unexpected result, the general effect of an accelerated developer when using pyro and ferrous oxalate not being in favour of additional brilliancy, at all events.

As to the use of meta-bisulphite of potash, Captain Himly finds that, when used in too great proportion, it retards development considerably, but it is notably more powerful as a preservative in the solution than sulphite of soda alone. When color of the image is important, however, it is not desirable to omit the sulphite of soda, or even to reduce the amount of it, when meta-bisulphite of potash is used, as the former salt has such a beneficial effect upon the colour of the deposit.

As the result of Captain Himly's researches, he recommends the following developer, here put into English measures:

HYDROQUINONE AND CAUSTIC SODA DEVELOPER.

Solution A.

Hydroquinone	40 grains.
Meta-bisulphite of potash	16 "
Water	2½ ounces.

Solution B.

Caustic soda	1 ounce.
Water	8 ounces.

To 5 ounces of water, ½ ounce of each the above solutions is added. This developer is recommended as very good for negatives, but not for positives upon bromide of silver emulsion paper, as the tone is very unequal, and for the most part of a reddish color.

HYDROQUINONE AND POTASH DEVELOPER.

Solution A.

Hydroquinone	40 grains.
Meta-bisulphite of potash	16 "
Water	2½ ounces.

Solution B.

Carbonate of potash	1 ounce.
Sulphite of soda	½ "
Water	10 ounces.

For development, ten parts of A and from fifty to seventy-five parts of B are added to from fifty to twenty-five parts of water, according as it may be desired to produce a soft or a powerful negative. As accelerator, six minims of the one in eight solution of caustic soda above mentioned is to be added. The addition is stated to have also a favorable influence upon the color of the deposit. This developer is also recommended as very suitable for positives.

HYDROQUINONE AND SODA DEVELOPER.

Solution A.

Hydroquinone	40 grains.
Meta-bisulphite of potash	20 "
Water	2½ ounces.

Solution B.

Carbonate of soda	1 ounce.
Sulphite of soda	½ "
Water	10 ounces.

For development, to ten parts of A from fifty to seventy-five parts of B are added, and fifty or twenty-five parts of water, as with the potash developer.

This developer also works noticeably better when six minims of the one in eight solution of caustic soda as accelerator is added. The developer works exceedingly well, both for negatives and for positives upon bromide of silver emulsion; and is especially good for the latter purpose, the tone being very even. It is recommended, before washing, to immerse the print for a short time in a dilute acetic acid solution, which discharges any yellow colour that may have appeared upon the paper. The use of a bromide as a restrainer is unnecessary, this function being sufficiently fulfilled by the meta-bisulphite of potash.

In the table of comparative results given by Captain Himly, caustic potash shows a less favorable action than caustic soda, and the latter is therefore recommended. On other accounts—less cost and greater freedom from impurity—soda is also to be preferred.

The carbonate of soda required is not the powder sold under that name, and known also as sesqui-carbonate and bi-carbonate, but the crystals. Washing soda, if moderately pure, generally answers perfectly. The precaution of using for the hydroquinone solution either distilled water or water that has been boiled and allowed to cool, must be observed, as well as that of thoroughly dissolving the sulphite—when sulphite of soda is used—before the addition of the hydroquinone. Sulphite of soda must be in good condition—must not have effloresced.

Development by hydroquinone has been making way by leaps and bounds. The present modification—that which removes the one most serious objection hitherto raised to its use (slowness of action)—appears at the same time to confer additional good qualities to the negative itself, and seems likely to bring the method into a much more extended application than it has hitherto enjoyed.—*Photo. News.*

TIME SERVERS.

How many men there are, holding good, paying positions as journeymen, who are really of no value unless kept constantly under the eye of the foreman or their employer! They are simply time servers, who take no interest in the business they represent beyond the actual time necessary to count them a day's work. They work when closely watched because they are obliged to, not from any motive of honor or interest in the business.

What can be expected of such workmen but that they will shirk their work and idle their time at every opportunity?

If you cannot give your employer your full time for which he pays, and take some interest in his business, you had better leave him at once. To this he is entitled, and has a right to expect it of you.

If your mind is not upon your work, you cannot expect to accomplish it with any degree of satisfaction to your employer or credit to yourself.

In going about from one shop to another it is a very easy matter to pick out the time servers. Upon the slightest pretext they drop their work to talk or look about, and are always ready to get out of the door the moment the clock strikes six, and their example is very rapidly followed by the apprentices or younger workmen. They have to be constantly watched, and this fact, being known to the firm, is not long in having its results.

Employers are more generally knowing to the habits and qualities of the men they employ than the men often realize, and they invariably know who are the time servers among them, so that when there comes a convenient opportunity or a lull in business, these are the first to be discharged.

It pays to be faithful and to do your best at all times, and more especially when your employer is not watching. If you must idle away time, do it when he is about, but don't dishonor yourself or betray his confidence by taking advantage of his absence.

This is one of the worst features of our American system. It is an example which is set by the older men, and which is readily adopted by apprentices, and it is the exception rather rather than the rule that we find a young man who is sufficiently interested in his own welfare and his employer's as well to give his full time and attention to his work. Those who do this are sure of success, and it is from among such that have risen those men whose names are written upon the pages of history as having made their mark in the world, and left behind not only pleasant recollections, but a shining example that is worthy of a careful imitation.—*The Practical Mechanic.*

CARE OF WATER WHEELS.

When a mill owner buys a water wheel and puts it out of sight under his mill, he expects that wheel to "keep right along eating shad" fifty-two weeks per year, and never stop for bones. Some men have been known to purchase a steam engine, and, after once starting up, run the machine 130 hours per week as long as the engine held together. Occasionally, way back in saw mills, this sort of thing is tolerated now-a-days, but the increased price of coal has induced most steam users to become progressive, even when other considerations failed to move them.

It would be barbarous to treat an engine as above described, yet water wheels are subjected to just that kind of care, year in and year out. The "best wheel in the world" is purchased and dropped into the wheel pit. Nothing more is thought of that triumph of hydraulic engineering until the gears fall out of mesh, and the mill stops running through the burning out of a step. Repairs, in such cases, often consist merely of a new step, a new bolt or two, and a hurry to get out of the wheel pit.

Water wheel repairs are not often called for, except to the case or penstock, but, like many other repairs, could be made valuable. A water wheel is a rusty looking concern, not at all interesting to the owner, who too often gives it a poke with his cane, decides that it is "all worn out," and listens to the smooth tongued agent of another "best wheel made." If the old wheel could have $10 laid out on it for repairs, it would have done good work for ten years longer, and perhaps have delivered more power than the new wheel.

It will pay to let Mike clean the rust off the old wheel and polish it up with a wire scratch brush, such as is used in the foundry. A vigorous use of this tool, reinforced by a cold chisel and hammer, will work such a transformation in the old turbine that its owner would even forget to give it the conventional poke with his cane.

A water wheel, once clean, should be painted with boiling hot gas tar and allowed to dry at least two hours—better two days—before being put back into the pit. The case should receive the same treatment. Lumps of rust on the chutes of turbine wheel cases do not add to the power derived from the water, and the cleaner the chutes, the better the percentage available.

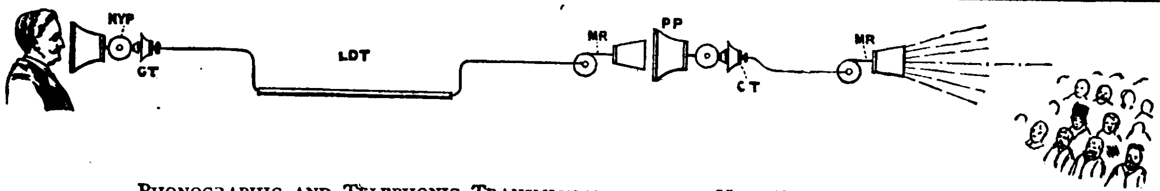
It pays to shut out the water once in three months and crawl into the wheels. If a man takes with him on these occasions two quarts of brains, a monkey wrench, a cold chisel and a hammer, he can crawl out of the wheel in two hours time knowing that the turbine is many dollars better than when he went to it.

Perhaps a crank rod is broken, which allows one of the gate chutes to remain open or shut, as it may chance to lie. In this case waste of water is taking place when the wheel is idle, or a fraction of the wheels entire power is lost by the chute remaining closed at all times. To determine this fraction, regard the numerator as one and the entire number of chutes in the wheel, or gate, as the denominator. The segment gears, if there are any in your make of wheel, may become badly worn, and they will wear badly under water, causing only a partial opening or closing of the gate, and quite a loss of power and water thereby.

A little bolt may get loose, fall out or rust off, letting the end of a lever get loose. Perhaps this may cause a leak of water or of power, or it may cause a tremendous breakdown, which might ruin the wheel, its case, and perhaps the main gears as well. The quarterly visit to the wheel enables the millwright to nip in the bud many of these incipient breakdowns. He applies new parts, and, in fact, does the repairs "just before they are needed." He prevents breakdowns by anticipating repairs.

The whole turbine business may be summed up as follows: If a manufacturer would treat his water wheels half as well as all his other machinery is treated, they would do more work with less water, last longer, need replacing less frequently, and cause fewer breakdowns than they do under existing methods of careless handling? Every mill owner ought to make his millwright a New Year present of $10 or $20, with the request to pay it back by "taking care of the water wheels" during the coming year. It would repay the investment many fold.—*Paper Trade Journal.*

An Electric Actinometer.—Messrs. Gony and Rigolles have devised a small battery of peculiar construction that may, according to the *British Journal of Photography*, be used as an actinometer. It is made by heating a clean plate of copper over a Bunsen burner till a layer of cuprous oxide forms; this plate, with one of unaltered copper, forms the battery. A galvanometer is introduced into the circuit and the battery then exposed. The effect is instantaneous and disappears when the light is cut off. Diffused daylight produces an alteration of several hundredths of a volt, direct sunlight an alteration of at least a tenth of a volt. It is stated that with a Thompson galvanometer it is possible to recognize the effect of a candle flame at a distance of several yards.



PHONOGRAPHIC AND TELEPHONIC TRANSMISSION BETWEEN NEW YORK AND PHILADELPHIA.

N.Y.P. New York Phonograph. C.T. Carbon Transmitters. L.D.T. Long-distance telephone line, 103 miles, 6 miles underground. M.R. Motograph Receivers. P.P. Philadelphia Phonograph.

PHONOGRAPH AND TELEPHONE.

On the evening of February 4th, Mr. William J. Hammer delivered a lecture on "Edison and His Inventions" before the Franklin Institute, Philadelphia. This remarkably able lecture was replete with interest, and described in sequence all of Mr. Edison's inventions in the field of telegraphy, telephony, phonography, electric lighting, etc., all of which were made clear by a wealth of illustrations and experiments.

Perhaps the most striking experiments shown were those in connection with the telephone and phonograph, and consisting in the recording and transmitting of telephone conversation, music, etc. The first experiment undertaken was the recording on a phonograph in Philadelphia of music and talking transmitted over the long distance telephone line from New York, and reproducing the same to the audience.

Another experiment consisted in recording music and talking upon the Philadelphia phonograph which had been talked into the long distance telephone by a phonograph in New York.

The most important test was that which is illustrated diagramatically in the accompanying sketch. This consisted in reproducing to the audience, by means of the Edison motograph receiver or loud speaking telephone, and the Edison carbon transmitter, the music and talking registered on the Philadelphia phonograph, and which had been sent over the long distance telephone line from New York (a distance of 103 miles) by the New York phonograph talking into a carbon transmitter. This wonderful experiment, as will be seen, employed two phonographs, two carbon transmitters and two motograph receivers acting in juxtaposition with 103 miles of telephone wire, six miles of which was underground. We are indebted to Mr. Hammer for a copy of the above diagram.—*Electrical Review.*

BERRY'S ELECTRIC BELL.

Fig. 1 shows the electric bell ready to fix against a wall or stand upon a table: it is equally suitable in either place. The plated bell or dome is fixed in the centre of a well-turned and polished mahogany base with two lacquered brass terminals at the top, and two brass screw cups, one on each side, to take the screws which fix it to the wall. The whole of the working parts of the bell are hidden beneath the dome or bell itself and therefore cannot be tampered with without removing the top screw with a screw driver. It is neat, compact and ornamental in appearance.

Fig. 2 is a plan of the working parts, the dotted lines showing the position of the bell and the lug upon which the hammer strikes. The electromagnet consists of one bobbin only with iron cheeks, the two cheeks forming the two poles which attract the small armature or hammer that strikes the bell. This bobbin is fixed upon the iron frame which also supports the bell or dome.

It rings very powerfully with one small Léclanche cell. The low price of this bell is arrived at by its simplicity of construction, the materials and workmanship being thoroughly good throughout. Considering the large demand there is at the present time for a good, cheap, and ornamental electric bell, we think, from a personal inspection, that this article will have its share of patronage.—*Electrical Review.*

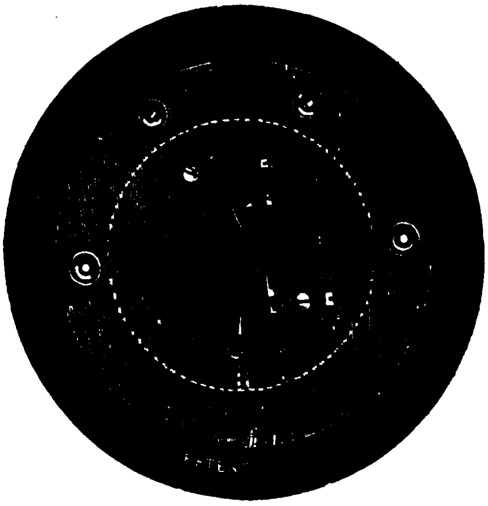
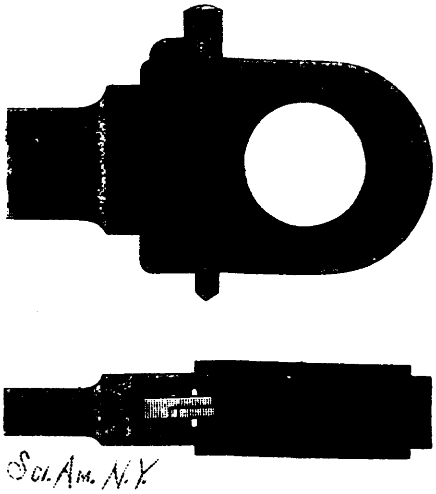
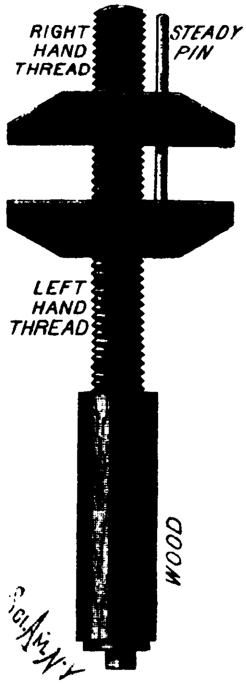


FIG. 1.

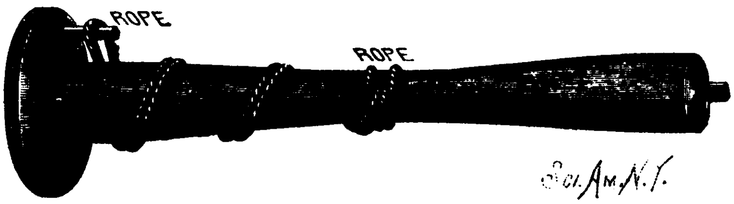
FIG. 2.



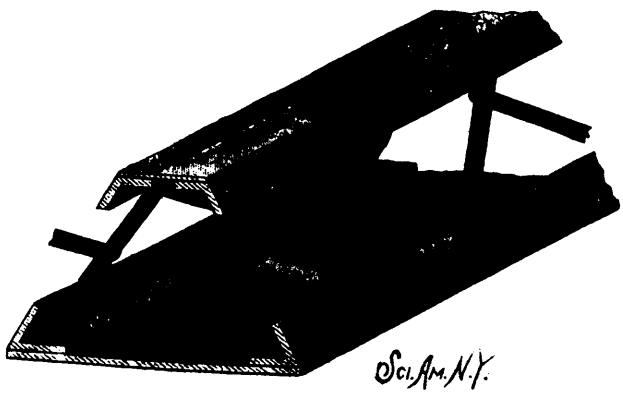
A French Method of Fastening Connecting Rod Keys.



A French Monkey Wrench.



A French Method of Driving Axles in the Lathe.



The Girder for the Line Shafting at the Paris Exhibition.

THE PARIS EXHIBITION.

[FROM SPECIAL CORRESPONDENT OF THE SCIENTIFIC AMERICAN.]

The International Exhibition now begins to assume a more definite character, and the easy manner in which operations within it are being carried on indicates that the authorities are of opinion that all will be ready for the opening day—a consummation most devoutly to be wished, but rarely accomplished in the case of exhibitions, and especially those containing machinery.

The only part in which any pressing activity is apparent is in the grounds. The old soil (which looks as if much of it had at some time or other been paved with cement) is being carted away and replaced by a very rich mixture of peaty loam for the gardens. Among the trees and bushes that have been planted are some good samples of magnolias, but it is doubtful they will bloom this year, on account of having been so recently planted; nor do I think that the gardens will show to any very great advantage, except in so far as the flower beds are concerned, and one rockery that is already finished.

The utmost activity is being shown in grounds round about the Eiffel Tower, where the ground is deep in mire through the wet weather and the cartage of soil, which is being done in the usual one-horse cart that tilts to dump, nobody here seeming to have any idea of the American four-wheel cart with movable bars at the bottom, which is so much more handy. With the two-wheel cart and the horses tandem, the shaft horse does nearly all the work, and the two horses rarely start to pull together. There is so little moving of earth in London (whether because of its flatness or that there is less improvement, it is hard to say) that there is some excuse for using the old tilting cart; but one sees a great deal of this class of work in Paris (or, at least, such has been the case for the past few months), and American carts with movable bar bottoms would find plenty of use.

I mentioned in my last letter that the hoisting engines on the Eiffel Tower had Porter governors on them, but I omitted an item that I now supply, to wit, a piece of what I certainly consider, to say the least, unnecessarily expensive construction on at least one of the engines, and a sketch of which is given herewith, being the crank pin end of a connecting rod in which the key is secured by a small bolt and nut, the bolt passing through a slot provided in the key and through a projection on the head of the gib. This is a very expensive method of holding a key, and no better than a set screw.

First impressions are often modified by experience, and are hazardous to put in black and white; but, nevertheless, I venture to say that my first impressions of French engineering are that it is in a transitory condition, and that while I find much that is old and discarded in the United States and in England, nevertheless I find much that is new and evidencing a desire to adopt the most advanced methods.

In a former letter I called attention to the copying of American machines in England, and I see that since then one of the sufferers named by me (the Brown and Sharpe Manufacturing Company, of Providence) have publicly protested against this copying.

Now, I do not desire to enter into the moral ethics of copying, or the circumstances under which it is justifiable or otherwise; but I do wish to point out that, looking at the matter from a purely mechanical standpoint, I would sooner see a copy of a first-class machine than a poor attempt to accomplish the same end by a roundabout method in order to avoid the stigma of copying. For instance, I saw in a large woodworking shop in London some emery wheel machines for saw sharpening, and they were a skeleton framework of wings and arms that one almost expected to see crawl around like a spider. To my mind, the designer had far better have copied some American machine right out, and the only consolation one had in looking at the machine was that the designer had at least had sense enough to know the value of emery wheels for sharpening purposes, and that is more than a good many, both in France and England, can say.

I have seen in France some very ingenious machines that I consider a decided advance upon anything I know of in the same line, but I have also seen some that, while good enough, for a beginning, are not equal to American machines designed for the same purpose; but whether this arises from a dislike to copying or ignorance of the existence of the American machines, it is hard to say. In either event, however, it gives evidence that there is a market here for American machines as well as small tools.

Speaking of small tools reminds me to give you a sketch of a French monkey-wrench I saw the other day, the stem being threaded through both jaws, and a steady pin preventing them from turning with the screw. Now, putting aside the awkwardness of having the upper end of the screw stick out so that the wrench cannot be used in any other but the most open of situations, and the general heaviness and clumsiness as well as the uselessness of a double set of jaws, let us consider the cost of making such a tool as this as compared to that of making one of Coe's or any other first-class American monkey-wrench, and we shall see that there is more work in the right and left hand screw and the steady pin than there is in the whole American wrench.

But, before going any further, let me say that, while I propose to use an unsparing hand in criticising the machines and tools I find here, whether of French, English, or American origin, I shall nevertheless give a full measure of credit where it appears due, my object being to give a full account of all I see that is of interest to the mechanical world, and not to pick out either the good or the bad. This programme, however, naturally operates somewhat to the disadvantage of the French, since it is not the worst of English or of American tools or productions that are brought into France, the worst being left at home and not usually put forward by the home journals. As an illustration, take the case of the monkey-wrench, which is by no means a fair representation of that class of tools as generally found in France. Nevertheless, I found it here, and do not remember ever having seen a worse one, although I have seen some pretty bad ones in England.

A very neat and interesting wrinkle that I found in a French shop is that of driving an axle by a rope, as shown in the sketch. I never saw anything like it before, and am particularly pleased with it. There is no loose dog or clamp to slip about on the axle while it is being put in the lathe or to fall off the live centre if it is hung there; there is no monkey-wrench to pick up or look for to fasten the set screw of the dog or clamp; and, furthermore, the same sling will do for lifting the axle by the crane (if the lathe has one), and, finally, there is no slipping of the dog. A cut half an inch deep was being taken off the axle I saw this device on.

There is not much progress to report in the machinery department, but there are a great many foundations for engines and machines finished, with the bolts all in; and very solid they look, which is a source of comfort, as the giving way of foundations is not an uncommon occurrence at exhibitions, or, at least, this is sometimes put forward as the reason why a pound or a knock is heard when it should not be.

The girders for carrying the line shafting are all up, and I send you a sketch representing its construction. It is a built-up affair, composed of angle iron and plate, with braces. The shafting hangers are V-shaped, and are riveted to the plate, as shown in the sketch.

The window which occupies a great part (all the upper part) of the end of the machinery department is painted a pale yellow, with pale green and blue ornamentation, the latter also including some small crimson stars.

A good part of the ornamentation of the buildings is being made of sheet zinc, and I saw some (for the exterior of one of the domes) whose extreme dimensions were say six by seven feet. Finer examples of work in zinc I never saw or expect to see, the soldered seams being as clean and smooth as could be, notwithstanding their running around mouldings, beadings, etc. Indeed, there was not a sign of a crinkle or warp anywhere.

There are a great many cornucopiæ among the ornamentation (over 100 in the machinery department alone), filled with fruit, flowers, etc., and all these are worked up in zinc.

In some of the departments the cases are all ready for the exhibits, while in some instances these cases are being ornamented with plaster or stucco figures in a most effective manner, as the buildings are but temporary. These stucco figures serve very well and are light, being built up on a light wooden framework. A great deal of ornamental tile work is being used in the decorations, among which I noticed some tile casings for round columns, the sections being about two feet long, and in width embracing about a third of the circumference of the column. The surface had raised vines, leaves, flowers, etc., upon it, the whole giving a very pleasing effect.

J. R.

MR. WANAMAKER'S TESTIMONY.

There is too much impartial testimony as to the value of advertising to allow of the impeachment of the value of a newspaper's advice on the subject.

The words of John Wanamaker, of Philadelphia, ought to have a weight with men engaged in mercantile business. He says: "I spend $5,000 a week in advertising, and I pay a skilful man—a former newspaper editor, and a good one—$1,000 a month to do it for me. I make money by it. Advertising is the leverage with which this store has been raised up. I do not see how any large and successful retail business can be done without liberally advertising. I advertise in every issue, except Sunday, of every daily paper in Philadelphia. Continuous advertising, like continuous work, is the most effective."

Now, what has been the experience of this man, to make him so appreciative of the value of printer's ink? Mr. Wanamaker began life without a cent to his name. His father was a bricklayer and he himself went into a clothing store as a clerk when he was 14 years old. From that humble beginning he worked himself up by dint of energy and enterprise until now he is proprietor of what is probably the largest retail store in the United States.—*Waterbury Republican.*

A Swedish scientist claims to have discovered the secret of petrifying wood by artificial processes. He thinks it will be possible ere long to construct edifices of wood and convert them into stone. As it takes three months and costs about £500 to petrify a block of wood of dimensions of a cubic inch, it will probably be some time before this process will be generally adopted.

WIRING BUILDINGS FOR ELECTRIC LIGHT.*

BY J. D. F. ANDREWS.

The first points for consideration in devising a wire system for electric lighting are what contingencies will be met with that will affect the system, and what faults will arise in it after its introduction.

Through past experience it has been found that the practical pressure of electricity for electric lighting is within 50 per cent., either way, about 100 volts, the 100 volts being most generally adopted. The chosen conductor is copper, and the most widely adopted insulation is India-rubber in many modified forms. The insulated conductors are usually protected and held in position by wooden casing. We need hardly question the object of the conductor; but what is the object of the insulation? The conductors, if held in good dry wood casing only, would be well enough insulated, and would be protected from interference. Its object is to meet one of the worst contingencies, moisture or water, which is an ever working evil on electric light wires. If you place a copper wire in water with electricity passing along it the copper will be removed electrolytically from the part of the wire where the electricity enters, and deposited where it leaves. The same process goes on when uninsulated or badly insulated electric light wires lie in water or surrounded by moisture. Even though no electricity is flowing through a copper wire exposed to moisture and the atmosphere, it is acted upon chemically. The result of the electrolytic and chemical actions on electric light wires is to thin them and make them insufficient for carrying the current, and consequently they become heated; or the result may be that the wire is eaten through, when an electric arc is produced. This effect or fault is called an opening circuit, and is about the most difficult and dangerous fault to contend with. It is usual to lay the electric light leading wire in a groove in the casing neighbouring and parallel to the return wire. Water often saturates the casing between them, and when the insulation is poor the electricity will pass through the moistened wood and char it, often setting it in flame. Faults such as this, where a great leak is taking place between the wires, are called partial short circuits, and are equally difficult to avoid and as dangerous as opening circuits. The study of the insulation of the wires is therefore obviously of great importance. Most of the results in good insulation were obtained by telegraph engineers before the electric light business was started; but in the new business these results were almost entirely ignored.

Great insulation was then not considered necessary, and special covering for the wires was devised of a cheap and poor quality, which it is greatly to be regretted has continued in use by many contracts to the present day. As previously stated, India-rubber is the base of the insulation of most electric light wires, the purer the material the better the insulating properties; but pure India-rubber is easily influenced by air. At first it gets hard, and in course of time changes to a soft sticky state, when it is useless as an insulation. Pure rubber is still the foundation of insulation on the wires, but in the very best qualities it is protected from the atmosphere by an outer coating of what is known as vulcanised India-rubber. Such qualities of insulation consist of first one or two lappings of pure rubber, then a layer of India-rubber mixed with such minerals as soapstone, over which again is laid a coating of rubber mixed with a large proportion of sulphur. The wire, with its three coatings, is now subjected

* Read before the Glasgow Philosophical Society.

FIG. 2.

to a high temperature in a vulcan by means of steam, through which the rubber and sulphur combine, while any surplus sulphur is absorbed by the middle coat, which is called the separator. Such is the insulation of the best quality wires The inferior qualities, and those most generally used, are insulated simply with pure rubber and cotton serving, with ozokerite or other compound tape laid together in many different ways, according to the device of the maker. The compound tape is supposed to protect the pure rubber from the air, but it only plays this function to a small extent. The usual reliable life of such wires is from two to three years; and not being reliably waterproof throughout their length at any time, there is always danger of failure through moisture. Vulcanised India-rubber covered wires of the class above described (there are many inferior kinds) are perfectly reliable in water or air for a great number of years.

The next contingency that has to be contended with is mechanical damage. The wires being more or less flexible and the covering soft, they are easily damaged. This difficulty is usually met by casing the wires in wood; and it being necessary to employ two conductors for electric lighting, the casing has two grooves, one for each conductor, a cover being

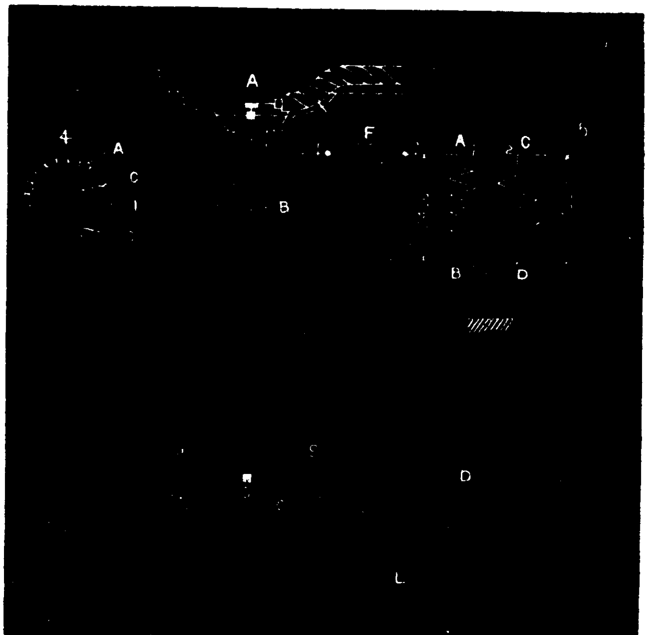


FIG. 3. FIG. 4. FIG. 5

fixed over them. Wood casing has the disadvantage of harbouring moisture. Another method of protecting the wires is that of sheathing them with an outer covering of wires as introduced by the writer some years ago into ship lighting. This method protects the wires much more effectually than casing, and does not harbour moisture. Iron pipes have been used in many cases, and are an excellent protection, but moisture collects in them; and if there should be a fault in the insulation it is sure to find it.

There is another fault besides the opening circuit and partial short circuit, not yet touched upon, namely, a dead short circuit or a direct contact between the opposite conductors. This is the most frequent fault, and if it were not that there is a simple appliance, called a fuse, to meet it, it would also be the most dangerous fault. Short circuits usually happen in the fittings, where the opposite conductors are necessarily brought nearer each other, and at these points the insulation is generally much thinner and poorer. Short circuits also often happen when the wires cross, and frequently by connection with gas or water pipes, which make very complicated faults, because the two wires usually touch the pipes a distance apart, which will be better understood by reference to diagram 1.

Suppose the current to leave the dynamo by the positive wire, pass to the lamps by the branch wires, and back by the negative branch wires through the fuse, F, and the negative main to the machine. Suppose, now, the positive branch becomes connected to a gas pipe at, say, A, this would not indicate itself in any way, and the installation would, of course, continue working just the same, until the opposite wire got connected to the gas pipe, say at B. Now the current will become excessive, more than the branch wire can carry without getting dangerously hot, before the main fuse, T, melts. In the above description it is assumed there is a safety fuse at F; but it will be observed the short circuit has bridged the wire in which it is inserted, and it is consequently useless. To avoid the excessive heating of the wires with such faults above referred to, it is necessary to have fuses, one on each wire, such as at F and S. Under such circumstances, when a short circuit such as described between A and B takes place, the fuse, S, would immediately blow and prevent danger. Let us again assume there are fuses on only the negative wires, we will see there might have been even a worse fault. Again, supposing a connection at A with the gas pipe, which is, of course, connected to the earth, we will assume the second connection to take place in the dynamo field magnets at C. The current will now traverse the positive wire to A, thence to the gas pipe to earth and back to the dynamo. This route is a short circuit, and one moreover that bridges both branch and main fuses, which we have assumed to be only on the negative wire, as is still the practice of some contractors. The consequence of this short circuit is similar to the one from A to B, but worse, because there are no fuses at all left to protect the system. Of course, with another main fuse on the positive wire such a short circuit could not continue.

There is, however, objection to the multiplication of fuses; they are a danger themselves sometimes, such as in the case of a partial short circuit that does not increase the current sufficiently to melt the fuse, but quite sufficient to heat it to a degree dangerous to any inflammable material in the neighbourhood, and it may continue in this condition some little time before it fuses, especially if it is a large one. Another point of danger from fuses is, when it melts it throws ou sparks of molten metal. Of course it will be said that these evils in fuses can be reduced by proper construction; that is true, but it is decidedly better to avoid, if possible, numerous points of danger in an installation resting on special construction, or the care of an attendant for their prevention; we will consider later how this, to a certain extent, can be achieved.

In the foregoing we have considered mainly the contingencies or dangers arising with the introduction of electric light into buildings, and we may summarise the main points as being, an opening circuit, a partial short circuit, a dead short circuit, and the fuses. We have considered the dead short circuit to be met by the fuse; although a new element of danger is introduced which, however, is much less in degree. This new element of danger can be reduced to one-half by connecting one of the leading wires, say the positive, to the earth and the gas and water mains, it being only on account of the latter that it is otherwise necessary to provide a fuse on each wire. Diagram 2 will show this more plainly. The current leaves the dynamo by the positive terminal and meets at once a connection to earth and the gas and water mains, then proceeds by the positive wire to the lights and back to the dynamo. This connection to earth is wilfully effecting the fault we suppose might happen, as in diagram 1. But in making the connection to earth we are careful to do so with that wire which has not got the fuses inserted in it, which is contrary to the action of the fault in diagram 1. Now, if any of the negative wires come in contact with the gas and water pipes, a fuse must instantly blow, as if the two conductors themselves had touched. All the electric light fittings would in this case be connected with the positive wire, the negative wire passing down the centre of the tubes. There being in the fittings only a single wire which can be heavily insulated and made stouter, there is an additional safety against short circuits and fuse melting, besides the very great advantage of being able in a very simple way to wire each part of an electrolier or fitting. Diagram 3 illustrates how this is effected. The current travels from the contact, A, down the wire, E, through the contact, O, to the switches, S, S, by the wire, D, to the lamp, L, and back by the brass of the fitting to the ball and socket at the top and away by the earth wire. The wire inside the tubes is never smaller than No. 14 S.W.G., and the contacts are made with a strong small spiral spring. The contact at the ball and socket joint projects through, and being a box spring, it gives and takes with the swing of the fitting and scrapes on a fixed brass plate in the roof plate. Single or universal joints are quite simple to construct with this system within the same dimensions as for gas, whereas with the two wires passing through the fitting such is impossible.

This method of connecting one of the wires to earth is best called the earth system; it is, however, often called the single wire system, because in its application to ships the hull of the ship is used as the return wire. In buildings, however, two conductors are required, and as it is important always to be able to distinguish between the negative wire in which the fuses are inserted and the positive wire which is connected to earth, and all the electrical fittings, the positive wire is coloured red and the negative wire black. The object for connecting the positive wire to earth is that red coloured wires are usually inferior in insulation quality to black wires, and it is not so important that the return or earth wire should be so highly insulated as the leading wire.

We now come to the consideration of means for minimising those most dangerous faults, opening and partial short circuits. Except the means proposed by the writer in the following paragraph no attempt has been made to treat these faults except by good workmanship and material. The proposal the writer makes is to universally adopt the sheathed or armoured wire system devised by him some years ago for use in the exposed and damp places on board ship, using the earth wire system, and now extensively used for that purpose. The virtue of this system is that all faults, partial short circuits and opening circuits, are reduced to dead short circuits. Fig. 4 is an enlarged section of an armoured wire, such as is now in use. The pink portion, C, is the copper conductor; I is vulcanised India-rubber insulation of the highest class, with a serving of jute and special compound, S, between it and the iron armouring, Q, which is a great many times larger in cross section than the copper conductor, care being taken that it is always more than seven times larger, this being about the difference in electric conductivity of the two metals. It will be understood that the copper wire is the lead and the iron wire the return. It was assumed in devising this system that the opening circuit in the outer conductor was very unlikely to take place, and so it has been found in practice. It is, however, possible that the inner conductor, through undue strain or a flaw, might have an opening circuit in it; and if such were to take place the immediate result would be that the heat generated would destroy the insulation between the two conductors and at once effect their fusion together and a short circuit. As a matter of fact, however, short circuits in this system have in practice been many fewer, and there have been no opening circuits or partial short circuits. How many of the short circuits were due to such faults is difficult to say; the causes of some were doubtful.

The writer is not aware of any new danger or contingency being introduced with this system of concentric wiring, although he has heard that some people object to it, and, in fact, to any system in which an earth connection is introduced; but he has still to learn upon what grounds the objection is based.

In addition to the advantages above referred to, there is another, not of least importance. The electricity being entirely enclosed within the outer conductor, and the electric pressure being only from the centre point to the outer conductor, it is impossible to get a shock through anything more than a very small part of one's flesh, such as the finger end, except by wilful contrivance.

It is advisable before closing this subject to consider how a system of wires supplying a town would be effected by an earth connection of one of the conductors. With any system of supply embodying the series system I may generally say it is not advisable to employ an earth. I have expressed this point broadly, as it involves complex considerations which would take long to make quite clear. But with all systems on the parallel system there are many points favourable to an earth connection, some of which can be gathered from foregoing descriptions. It is now important for us to find out whether there is any objection to its use, and with this in view diagram 5 is placed before you. It illustrates a transformer with its primary leads, and an electric pressure of 2,400 volts at the terminals, A and B, where they join the primary circuit, 1, of the transformer. F is a fuse in the primary circuit. 2 is the secondary circuit of the transformer between the terminals, C, D, of which there is represented a pressure of 100 volts. The terminals, B and D, of the circuits of the transformer are connected to earth, and consequently connected together. The writer is unable to find any danger in thus connecting the 100 volt pressure circuit to the 2,400 volt pressure circuit. Nobody could get a shock to earth, because the pressure between the return wire and earth is reduced to *nil*. The next point is, is there any greater probability of the insulation of the transformer breaking down because the circuits are joined together at one end. This seems to the writer to be answered by a simple calculation. With the earth connection there is no pressure at one end, but all the pressure, whatever it is, at the other. With no earth connection the pressure is alike at both ends, but at each it is only half the total. The result in both cases is the same. Suppose a connection did get made between the terminals, A and C, in addition to the earth connection, why the 2,400 volt circuit would be simply short-circuited, and the fuse, F, would melt. There is, it is true, a very remote possibility of danger in the event of the great improbability of three circumstances happening in succession—namely, first of all, a connection between the terminals, A and C, as well as the earth; then the fuse, F, not melting; and, thirdly, the circuit of the secondary of the transformer to open between the terminals, and thus put this 2,400 volts pressure on to the lamps direct, which would, as a matter of course, immediately gasp their last.

There is one other circumstance worthy of mention in favour of earth connection. Should the wire system at any time be struck with lightning, there is at once a safe connection to earth, instead of having to pass through a highly insulating material, as when there is no earth connection. Lightning has already been known to strike overhead electric light wires and discharge itself through the dynamo to earth, to the imminent danger of the machine.—*Electrical Review.*

USEFUL ELECTRICAL QUESTIONS FOR TROPICAL CLIMATES.

Under this heading, our contemporary, the *Electrical Engineer*, of March 15th, asks the following questions:—

1. Is the coefficient of variation of resistance with temperature mathematically correct for copper coils, and more especially for galvanometer coils?

2. Is capacity variable with temperature?

3. Are high resistance coils of platinum-silver reliable, or is it not a fact that, under certain climatic conditions, they show residual charge—that is, act to a certain extent as a secondary cell, destroying the accuracy of tests?

With regard to the first question, it is generally accepted that the coefficient for variation of resistance with temperature is correctly assumed to be, for copper 0·209, for German silver 0·024, for silver platinum 0·017, and for platinum iridium 0·034 per cent. per degree Fahr.

We believe, in reply to the second question, that it is generally admitted that the effects of temperature on capacity are, so far as practical work goes, absolutely nil.

In answer to the third interrogation, we consider that provided the silk covering of the wire is well dried at a high temperature and the coils are afterwards saturated with hot pure paraffin wax, so that moisture is excluded and not bottled up, there will be no error through polarisation. Where climatic conditions affect in a great measure the resistance of coils, is, of course, with regard to the marked value of the coils. These are adjusted at a certain temperature, and when used in a much higher or lower temperature than that at which they were adjusted, would manifestly indicate erroneous resistances, and consequently necessitate correction. A difference of 30 degs. Fahr. either above or below the temperature at which the coils were adjusted, would be equivalent to an error of 0·84 per cent. in the reading, or to an absolute error of 4 degs. Fahr. in the apparent temperature of the core of a cable as calculated from the conductor resistance when the latter is measured by the coils in question.—*Electrical Review.*

SPEED OF ELEVATORS.

The elevator was invented by Oliver Evans, a century ago, and from his day to ours its speed has been a subject of discussion among millers. The general speed is for six-inch pulley 125 revolutions per minute; a 22-inch pulley 180; and a 20-inch pulley 250 revolutions per minute. The outer edge of the cup travels faster than the pulley in passing over it, and a greater speed especially in the case of larger pulleys will throw the grain from the head and catch it in the points of the cups.

The following table of speeds will be found to be nearly correct in practice, but the speed can be increased or reduced to suit, this table being a fair average:—

Size Pulley, Ins.	No. Revolutions.	Size Pulley, Ins.	No. Revolutions.	Size Pulley, Ins.	No. Revolutions.	Size Pulley, Ins.	No. Revolutions.
6	75	17	46	28	31	39	26
7	73	18	44	28	30	40	25
8	69	19	41	30	29	41	25
9	65	20	39	31	28	42	25
10	63	21	38	32	27	43	25
11	59	22	37	33	26	44	25
12	56	23	36	34	26	46	24
13	52	24	34	35	26	45	23
14	50	25	34	36	26	47	22
15	49	26	33	37	26	48	21
16	47	27	82	38	26		

This speed can be varied 10 to 15 per cent. either way, as may be necessary through any change of motion of machinery, and as a fair average it will be found to give general satisfaction.—*Milling World.*

To mix aniline dyes, either soluble in water or alcohol, with an oil varnish. Use aniline dyes soluble in alcohol, and having made an alcoholic solution of them they will readily mix with any varnish.

How to bleach shellac. Making varnish as near transparent as possible: Dissolve the lac in a boiling lye of pearl ash or potassium hydro-oxide (caustic potash), filter it, and pass chlorine through the solution until all the lac is precipitated. Collect the precipitate, wash well in hot water, and finally twist into sticks, and throw them into cold water to harden.

ABSTRACTS AND EXTRACTS.

A DESIGN FOR A STANDARD OF ELECTRICAL RESISTANCE.*

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In designing a standard of electrical resistance the two points to which attention is directed are the choice of the material in which the standard is embodied, and the form or disposition of the instrument.

Experience is yet far from complete as to the entire permanence of wires of alloys over prolonged periods of time when employed as standards of electrical resistance; but having regard to the inconveniences which attend the use of mercury in standards intended to be conveyed about, evidence, as far as we have it, points to the tolerable permanence of the platinum silver alloy (66 p. c. of silver + 32 p. c. of platinum) when drawn into wire, for use as the material substance of which the actual standard is made.

A definite length and gauge of standard wire has then to be so arranged that, whilst kept at a constant temperature, currents can be passed through it and the resistance between certain points ascertained.

The form which has hitherto been chiefly manufactured, and which is in most general use, is the form of standard which was designed by the committee of the British Association on the original introduction of the B. A. unit. In this form of standard the actual coil is wound on a bobbin, consisting of a tube of thin brass having ebonite cheeks. Attached to these cheeks are the two long bent copper rods which serve as the electrodes, held in position by a distance piece of ebonite. In order that the coil may be immersed in a medium of known temperature it is further enclosed in a thin shell of brass consisting of a double tube, and the whole shell filled up with paraffine wax or ozokerit. Some makers then place a thin lid of ebonite on the top of the shell.

Experience gained by a rather extensive use of standards of resistance of this form has indicated to the writer that this design can be, with some advantage, modified. The disadvantages of the present B. A. form of standard are as follows: When in use the standards must be placed in water of a known temperature or in melting snow or ice. After a sufficiently prolonged time the temperature of this water can be taken, and the temperature of the water will be the temperature of the wire of the standard, assuming that equilibrium of temperature has been attained. If a current is now passed through the coil in order to take a measurement of its electrical resistance, the temperature of the wire is raised, and its resistance is altered.

Other things being equal, the best design of coil is that in which this electrically developed heat is got rid of by diffusion as quickly as possible. The embedding of a coil in a large mass of badly-conducting material like paraffine or ozokerit is, from this point of view, a great disadvantage.

Sufficient electrical insulation has to be provided; but this should be achieved without the use of more enveloping insulation than necessary.

The two chief objections to the B. A. form of standard are, however, these:—

1. It cannot be placed in water with the shell wholly under water or under ice without short-circuiting the electrodes, and, when used as intended, whilst the narrow or bottom portion

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* Abstract of Paper read before the Physical Society, on November 10th, 1888.

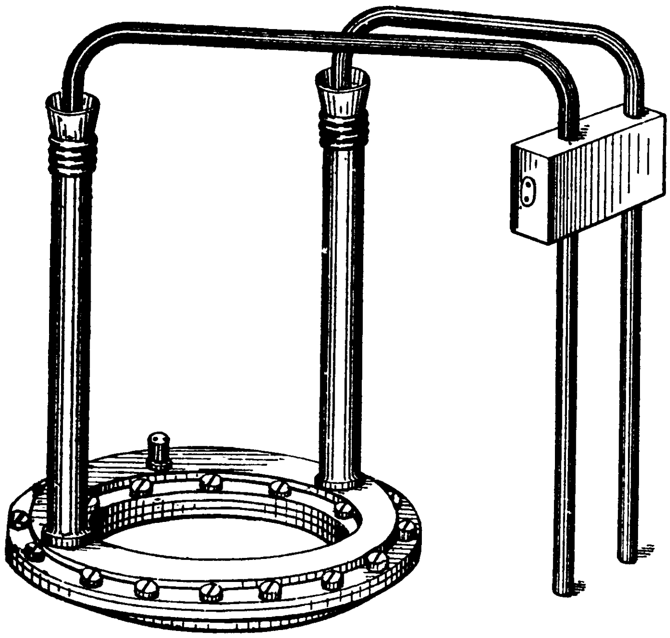

FIG. 1.

of the coil is in the water, the upper and more massive portion is in the air, and therefore may be at a different temperature to the bottom portion. Hence arises a doubt as to the actual temperature of the coil of wire. It has to be borne in mind that the limitation of accuracy in such comparisons of standards of resistance is determined by the difficulty of ascertaining temperature, and not in the mere measurement of resistance. Uncertainty as to the actual temperature of the wire to the extent of one or two-tenths of a degree Centigrade renders nugatory elaborate arrangements for very accurate measurement of resistance.

2. The standards, as at present constructed, are liable to another defect. If the standard is being used in melting ice or snow, and therefore cooled to 0° Cent., deposition of dew will take place upon the upper surface, whether it is the ebonite lid or paraffine wax surface, through which the copper rod electrodes protrude. The copper rods are originally lacquered or varnished, but when the lacquer wears off, any film of moisture so deposited will short-circuit the electrodes and reduce the observed resistance. In comparing standards in melting ice, either then the whole shell must be as far as possible placed under the melting ice, in which case stirring the liquid may splash water on to the surface of the paraffine, or else the shell has to be only partly immersed, in which case ambiguity exists as to the actual temperature of the coil of wire.

These and some other difficulties, such as that of keeping a rather deep vessel of melting ice at a constant temperature, have impressed on the writer the necessity for modifying the form of the standard; and one form which has proved itself to be very satisfactory in use is as follows :—

The case or shell which contains the coil is in the form of a ring (see figure 1). This ring consists of a pair of square sectioned circular troughs provided with flanges which can be screwed together so as to form a square sectioned, hollow, circular ring.

From this ring proceed upwards two brass tubes about five or six inches in length. Down these brass tubes pass the copper electrodes or rods, and these rods are insulated from the tubes at the top and bottom by ebonite insulators. The insulator at the bottom of the tube, where it enters the ring, is a simple collar, that at the top has the form of a funnel corrugated on its outer surface. The use of this funnel will be referred to presently. The actual resistance coil is a length of platinum silver wire three-fold silk-covered. The silk-covered wire is first baked above 100° C. to dry it completely, and then immersed in melted ozokerit or paraffine.

The so insulated wire is cut about the proper length and laid double or folded once upon itself and then rolled up on a wooden mandrel so as to form a circular coil of diameter suitable to drop into the hollow of the brass ring. The wire being

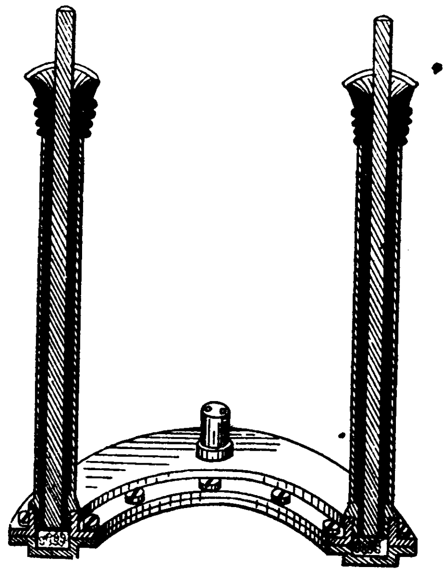

FIG. 2.

wound double, its coefficient of self-induction is rendered very small. This coil of wire is then wrapped over with white silk and again dipped in melted ozokerit. The ends of the wire are next soldered into nicks in the ends of the copper rods, they having been previously pushed a little way through the brass tubes for the purpose, and afterwards drawn back into proper positions. The coil is then packed into the circular groove, and, after adjusting the resistance to the proper value, the bottom half of the ring is placed over it. A thin washer of india-rubber is inserted between the flanges, and the whole screwed tightly together. The resistance coil is thus enclosed in a thin ring of metal, and can be placed wholly below the surface of water or ice. In order to test the tightness of the joints, a little test pipe is provided on the upper surface of the ring. By placing the ring coil below water and blowing into the test pipe, the good fitting of the joints can be assured. The aperture of this test pipe is afterwards closed by solder or a screw (see figure 2).

Apart from the insulation of the coil itself it will be apparent that the insulation is limited by the amount of insulation resistance secured at the ebonite insulators at the top end of the brass tubes. Any leakage from the copper rod over these insulators to the brass tube destroys to that extent the insulation of the coil. The object of making these external insulators funnel shaped is to prevent surface creeping, due to condensation of moisture on them, by placing paraffine oil or insulating liquid in the funnel shaped cavity. When this is done, even if dew should collect on the outer surface of the funnels the inner surface is kept dry by the paraffine oil placed in them, the action being the same as that in the well-known Johnson and Phillips fluid insulator.

The ring coils when in use are placed in rather shallow zinc troughs, which can be filled with water, and which are closed with a wooden lid. When so placed the whole of the actual coil or resistance part is down beneath the liquid at one level, where the temperature can be accurately ascertained. The insulators and point of emergence of the electrodes are away up above the level of the water, and well protected from any action which might permit of leakage over them. The large metallic mass of the ring assists in bringing the resistance coil quickly back to the temperature of the surrounding water, and the coil therefore "tests quickly." In all other respects these standards of resistance are as compact and portable, and not more expensive to construct than the old form of B. A. standard, whilst obviating the difficulties which present themselves in the use of the old form in very accurate comparisons of resistance.

It is quite possible to have two or more coils of wire inside the same ring, each coil having its separate pair of electrodes. A useful coil of this form can be made up containing 1, 10, and 100 ohms, so that comparisons can be quickly made at the same temperature with these three multiples of the same unit of resistance.

The adjustment of the coils to a certain value presents no great difficulties. The wire is in the first instance cut a little longer than required, and its resistance nearly adjusted; when the two ends of the coil have been soldered to the lower ends of the copper rods, the resistance is again taken from the ends of the electrodes. This resistance should be a little greater than the final value required. The middle point of the wire or extreme loop is now stripped of its silk and the loop twisted up with the pliers, the resistance being carefully taken at intervals. When just a very little in excess of the value required the twisted coil is touched with solder, and having been bound over with insulating material the coil is completed. In the construction of standards it is obvious that it is not so important that the resistance should have an exact integer value at any temperature as that its value at some temperature and its coefficient of variation of temperature should be exactly known.—*Electrical Engineer.*

NEW TABLE OF PISTON SPEEDS.

The following table, prepared to aid me in rapidly calculating the horse power of engines, shows the piston speeds in feet per minute, of engines of various strokes in inches, and at different rotation speeds. While the manner of its use should need little or no explanation, a few examples are added. It is assumed that every one who handles an engine knows that the piston speed in feet per minute is got by multiplying the stroke in feet by the number of single strokes (twice the number of revolutions) per minute; but it may sometimes be handier to look in a table than to reduce inch strokes to feet and then double and multiply by the revolutions per minute.

Engine 18 inch stroke, 200 turns a minute, look in horizontal column opposite 18, and in vertical column under 200; there we find the piston speed in feet per minute, 600.

Engine 60 inch stroke, 50 turns; piston speed 500.

Ft.	In.	50	75	100	150	200	250	300	350	400
½	6							300	350.	400.
⅔	8							400	466.7	533.3
5-6	10						416.7	500	583⅓.	666.7
1	12					400.	500.	600	700.	800
1⅙	14					466.5	583.3	700	816.7	933.3
1⅓	16				400	533.4	666.7	800	933.3	1066.7
1½	18			300.	450	600.	750.	900	1050.	1200.
1⅔	20	166.7	250	333.4	500	666.7	833.3	1000	1166.7	1333.3
1 5-6	22	183.3	275	366.7	550	733.3	916.7	1100	1233.3	1466.7
2	24	200.	300	400.	600	800.	1000.	1200		
2½	30	250.	375	500.	750	1000.	1250.			
3	36	300.	450	600.	900					
3½	42	350.	525	700.						
4	48	400.	600	800.						
4½	54	450.	675							
5	60	500.								
5½	66	550.								
6	72	600.								

—Robt. Grimshaw, in *Power and Transmission.*

London society is taking up the phonograph. Edison's agent is overwhelmed with applications for the use of the instrument for afternoon and evening entertainments.

To Stop a Chimney Fire.—Zinc, placed upon the fire in stove or grate, is said to operate as an effective extinguisher of chimney fires. According to this representation, when a fire starts inside a chimney, from whatever cause, a piece of thin sheet zinc, about four inches square, is to be put in the stove or grate connecting with the chimney. The zinc fuses and liberates aciduous fumes, which, passing up the flue, are said to almost instantly put out whatever fire there may be.

A lost colour discovered! Artists and scientific men have long wondered about "azzurrino," found in the ruins of Pompeii. M. Fonqué, the mineralogist, with a mixture of silicate of copper, and of lime, has now obtained the brilliant crystalline "azure" of Pompeii. It is a tint perfectly unchangeable, and identical with the Alexandrian blue which was first known to the Ptolemies, and imported into Italy in the first years of the Christian Era. The hue is "Sky of Heaven;" in fact, like Naples itself, "*pezzo di cielo caduto in terra.*"