Please mention the ELECTRICAL NEWS when corresponding with advertisers.

SPARKS.

The shareholders of the Cowansville, Que., Electric Light Co., announce their intention to dissolve the company and wind up the estate.

A sub-committee will recommend to the Montreal City Council that permission be granted a company to build and operate an electric railway from the city limits at Mount Royal avenue to Craig street.

The capital stock of the Sherbrooke Telephone Association will be increased by $10,000. Mr. J. A. Archambault has been elected president, Mr. S. W. Jenckes, vice-president, and Mr. C. Skinner, managing-director.

Special transportation rates will be granted the delegates to the Montreal electrical convention by the railroad and steamboat companies. The minister of customs has stated that all electrical appliances for the Exhibition will be admitted from the United States duty free.

Mr. Henry Leeds, of New York, visited Ottawa recently, for the purpose it is said of arranging with Messrs. Holland Bros., Canadian agents of the North American Phonograph Co., to place on the Canadian market a number of phonographs on the nickle-in-the-slot principle.

Experiments having in view the showing of the difference of cost between hand welding and electric welding have recently been made in England by an eminent firm. The result shows that the amount of work which by hand cost $45.77, when done by an electric welding machine cost only $30.25, an actual saving of $15.52, and the work was very much better and more soundly wrought.

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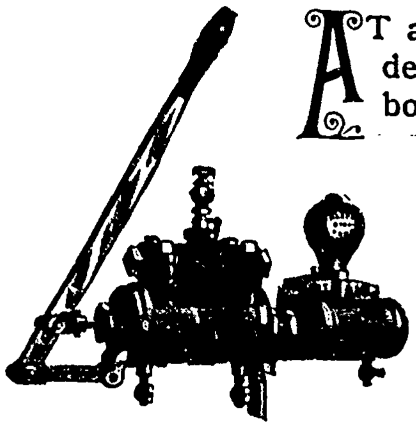

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As the exhaust mingles with feed water and returns to boiler, there is no loss of heat, hence it is the most economical pump in use. For hot or cold water or liquids, with or without Hand Pumping Attachment, NO PUMP EVER MADE THE RECORD OR BECAME SO POPULAR AS THE "MARSH."

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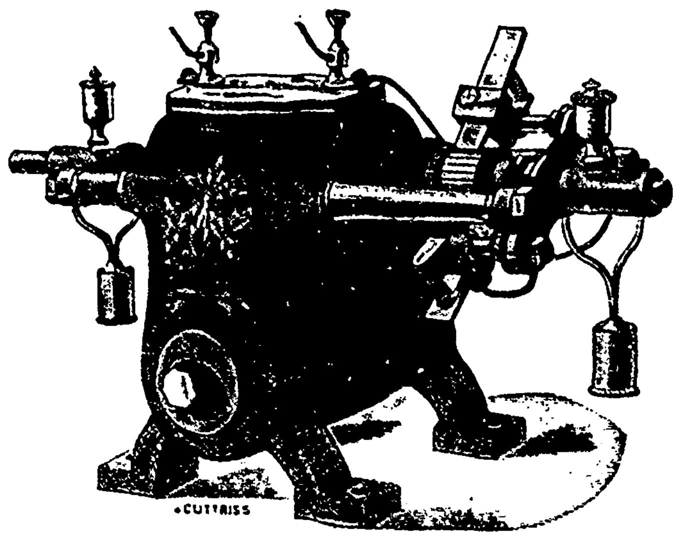

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CANADIAN
ELECTRICAL NEWS
AND
STEAM ENGINEERING JOURNAL.

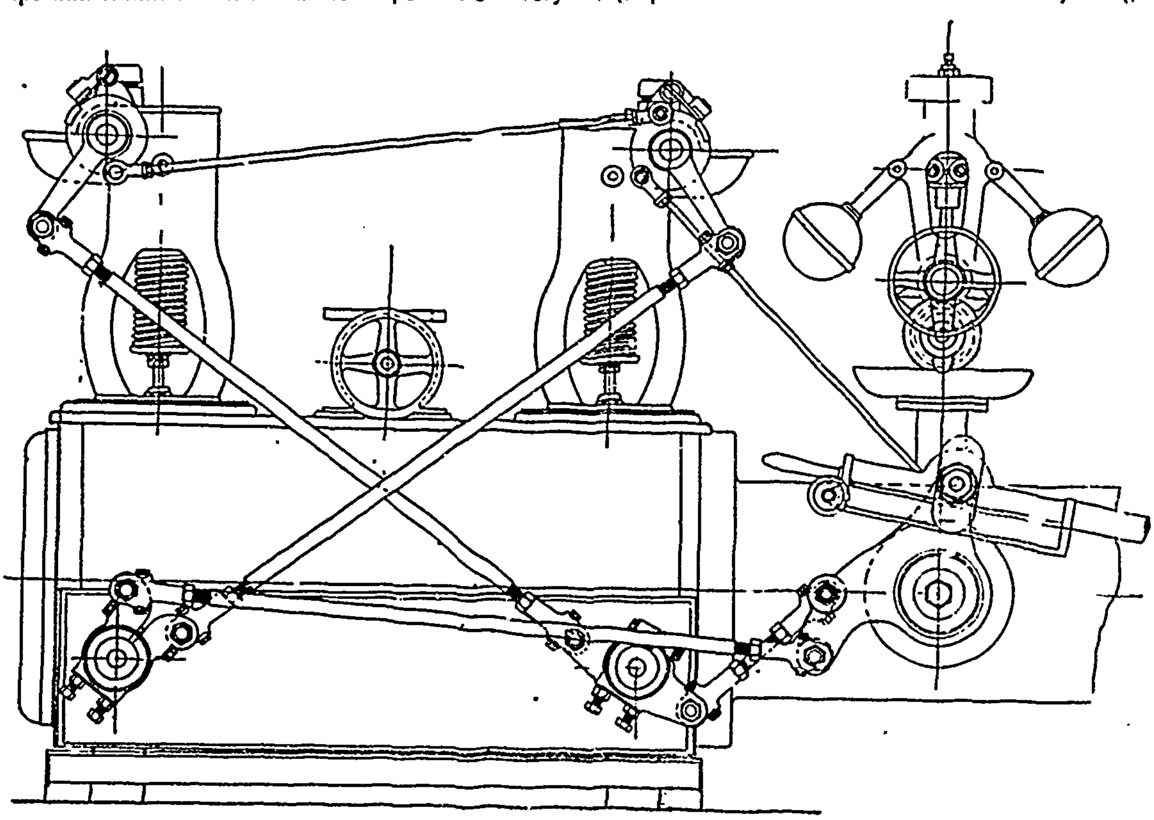
VOL. I. TORONTO AND MONTREAL, CANADA, AUGUST, 1891. NO. 8.

NORDBERG POPPET VALVE ENGINE.

THE Patent Poppet Valve Engine, illustrated herewith, is the product of the long experience and careful study of Mr. Bruno Nordberg, who for a number of years was the chief designer with the Edward P. Allis Co., Milwaukee, Wis.

The designer claims that it is constructed to meet the increasing demand for greater rigidity, strength, and durability of wearing parts. On account of the small tips of inlet valve, the latter will drop very quickly, enabling the engine to be run at a speed up to 150 revolutions per minute.

The shape and location of the wrist lever permits of a very short distance between centre of shaft and foundation, being on a 20 inch engine, only 22 inches, while that on some other engines of same diameter of cylinder is 30 inches. This, it is claimed, lessens the strain on the foundation, by reducing the tendency to rock it endwise, communicated by the momentum of the reciprocating parts.



The frame is of the girder pattern, cast in one piece with the main bearing and slide.

The post under the main bearing is considerably wider than the length of the bearing, and in it is provision for four bolts.

In designing the cylinder, the object kept in view was to increase the inlet valve area, and at the same time reduce the clearance. The clearance in the valve cavities is a great deal less than those commonly made. That of the exhaust valve is reduced nearly one-half, this result being obtained by its location and peculiar construction.

The external valve gear presents a great many radical improvements, as can be seen by cut. One feature of this valve gear is that the setting of the exhaust valves can be adjusted without changing the length of the valve rods, i. e., without disturbing the motion, by changing the angles through which the valves are intended to move.

Darling Bros., Montreal, who are manufacturing the Nordberg automatic governor, are the sole makers of this engine in Canada.

STEAM ADMISSION.

III.

THE valve being arranged to admit the steam in sufficient quantity and at the right time, the next point to consider is *how long should the steam continue to flow in, or should it be cut off?*

There are many different ideas held on this subject, and when high pressure steam came first into use many thought that the sooner it could be cut off, the better the result. Some engineers still hold this idea, and it would be a correct one were steam cylinders made of a material that was perfectly impervious to heat and quite unaffected by any change of temperature. Were it possible to make the cylinder of a material which once heated to the same temperature as the newly admitted steam would remain so, and not cool down, then a quick, sharp, early cut-off would be economical. But as cylinders are made, they absorb heat from the fresh steam, and thus a portion of steam is condensed. Then as the cut-off takes place, and the steam is expanded, the heat is returned by the cylinder and some of the water is again made into steam when it is too late to do any work, and so the heat taken out of the fresh, live steam, is thrown away. The greater the difference between the temperature or pressure of steam admitted to the cylinder and the temperature or pressure of the same steam when let out of the cylinder, the greater the loss from this cause. It may not all be carried off by the work of re-evaporating water, but some of it is wasted in doing that, and some of it in simply raising the temperature of the exhaust steam and water. Many experiments have been made to determine the best point of cut-off, and it may be taken as a result of these, that there is no economy in cutting off so early that the steam is expanded more than about five or six times in one cylinder.

Another very necessary point to determine is the pressure at which the exhaust steam is to escape. If the exhaust is to discharge into a feed water heater when there is a pressure of, say, 2 lbs. per square inch, then it is wasteful to make the cut-off so early that when the exhaust valve opens, the pressure in the cylinder is lower than that in the heater. Or if the discharge is directly into the air, there is no economy in having the steam expanded in the cylinder to a pressure below the atmospheric pressure.

The better way to determine the point of cut off is to construct an indicator diagram by fixing the amount to be allowed for each pressure, the pressure at the time exhaust is to open, and by drawing an expansion curve, then the size of cylinder and pressure of steam may be readily found for any required horse power if the speed of piston is known. It will be sufficiently accurate to calculate the points for the expansion curve by the rule that the pressure multiplied by the volume produces a constant quantity. Perhaps it would be better to describe the process of drawing a supposed indicator diagram.

First draw to parallel lines with a distance between them equal to 15 lbs., as measured by whatever scale has been chosen, such as 32 lbs. to the inch; then draw eleven parallell lines at equal distances apart, and at right angles to the first two lines. These eleven lines will divide the diagram into ten divisions. All measurements and calculation of pressures has to be made from the bottom line of the two first drawn. It represents the line of no pressure, the upper one representing the atmospheric pressure. The length of the diagram represents the length of the cylinder, multiplied by its area, which gives the volume of steam. This may be measured either in inches or feet, and care must be taken not to measure the area by inches and the length by feet.

Let it be determined that at end of stroke the pressure in cylinder is to be two lbs. above the atmosphere, then on the eleventh vertical line mark off two lbs. above the atmospheric line or 17 lbs. above the line of no pressure. Then the pressure of any other line can be found by multiplying 17 lbs. by the volume at end of stroke anddividing by the volume at the line for which the pressure is required. Having marked off the pressure thus found at each line, draw a curved line through all the points, this curved line will represent very nearly the actual expansion of the steam. Then at the first vertical line mark off the pressure of steam which can be admitted to the cylinder, an draw a line parallel to the atmospheric line till it cuts the expansion curve, this will represent the steam admission line of the diagram, and where it cuts the expansion line is the point of cut off required, in order that at end of stroke the presshre shall be 2 lbs. above the atmosphere, if the valves and piston are all right

ERRORS OF SAFETY VALVES.*

THE ordinary lever safety valve in use on ordinary boilers in nearly all sizes of boilers I have had charge of are about all the same class of safety valves; they call them "3-inch." Now we will see what "3-inch" is.

On boiler pressure 75 lbs per square inch, and also the flow of steam in atmosphere, 3 × 3, that is 7·6. Now then, 75 lbs. per square inch under valve, 7·6 × 75 570 lbs. dead weight on the valve stem. Now you set your weight on your lever according to your figures, then you test your boiler, and finding your weight is heavy, you say there is something wrong. Well, what is wrong? It is the valve seat, there is a bridge in that seat, ½" × 3", to guide the valve and to keep it in place. When it rises and drops that bridge—½" × 3"—reduces area of valve from 7.6 to 5.94 dead weight on valve, the stem would be about 445 lbs.; therefore, with friction 125 lbs. less than your figures (and that would not be the worst in reducing area of valve); by that bridge in seat you reduce the flow of steam in atmosphere. That is the error.

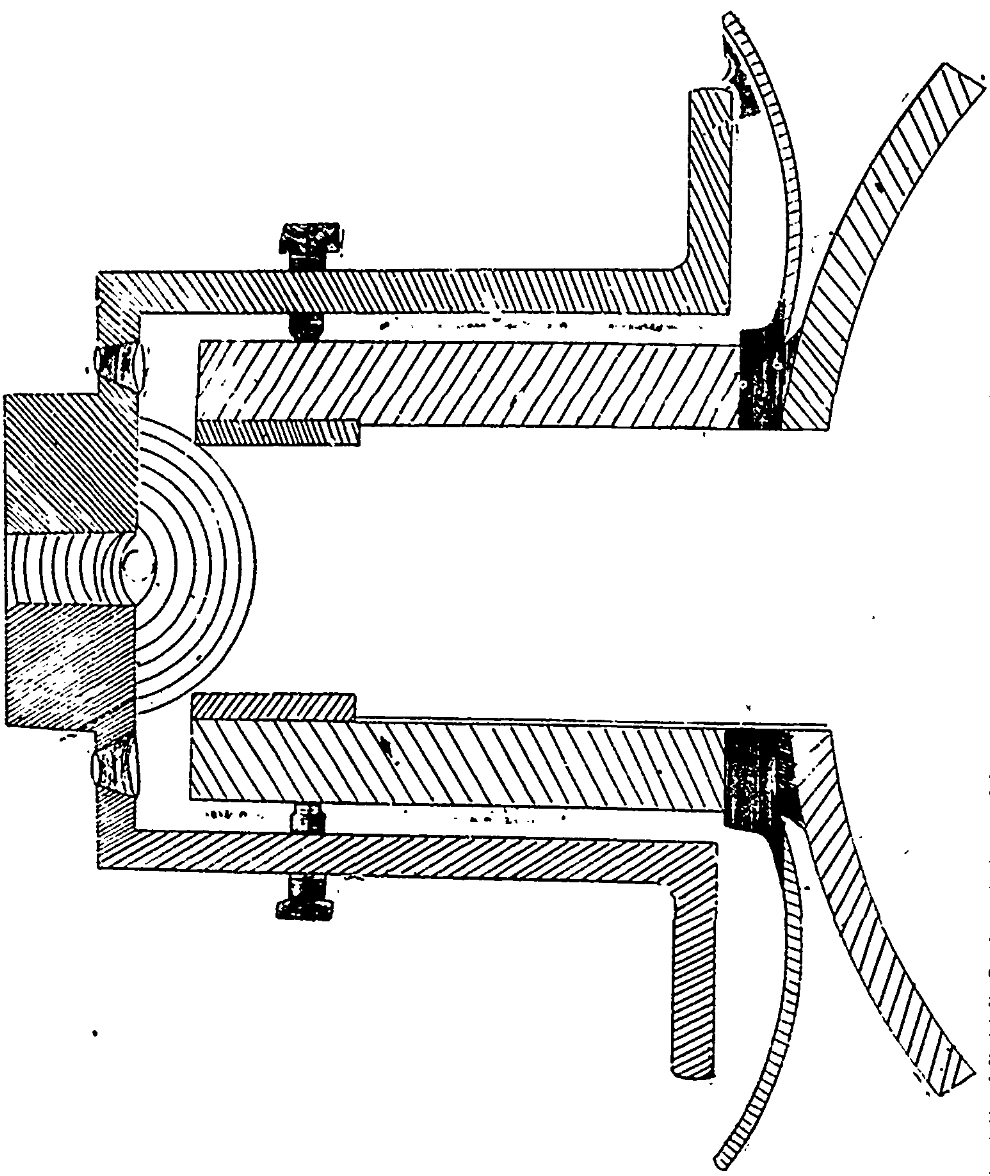


FIG. 1.—VALVE IN OPERATION, SHEWING INSIDE VIEW.

This valve I show you was designed in England some time ago. It was designed to do away with the lever and weight, and you will see by the design rivetted on the boiler — in the usual way, double rivetted— it is not only a proper, but what we are figuring on, a 3-inch valve. Should anything occur suddenly, requiring the full area and capacity of flow of steam as quickly as possible, this valve will do all that a 3-inch is called upon to do, for there is no friction. I think we should look after our boilers and safety valves more than we do.

The Edison General Electric Co. will fit up the new Manitoba Hotel at Winnipeg with combination electric and gas fixtures.

The Canada Electric Co., of Amherst, N. S., reports the following central station contracts. The Sydney Gas & Electric Co., 600 incandescent, Antigonish, N. S., Electric Co., 400 incandescent; H. A. Smith, Digby, N. S., 300 incandescent, all the above are direct current system, economic lamps, insulite sockets, using the Canada Electric Co.'s standard dynamos. We also have closed with the Gardner Mines Co., of Cape Breton, to install a complete wire cutting plant Jeffrey undercut machines and C. P. 40,000 watt 220 volt generator will be used

*Paper read before Montreal Branch, C.A S.E., by Mr. John Oades, M.E.

A ROUGH-AND-READY DYNAMOMETER FOR SMALL MOTORS.*

I HAVE been requested to bring to your notice a friction-brake dynamometer that is by no means new, but is one that is deserving of being more widely known by electricians than appears to be the case.

Like the well-known Prony brake, it acts as an absorption dynamometer; and without detracting from the acknowledged value of this instrument, especially for testing the value of large prime-movers, yet we need something more portable, more convenient to use, in the very numerous cases where it is desirable to test the efficiency of small motors.

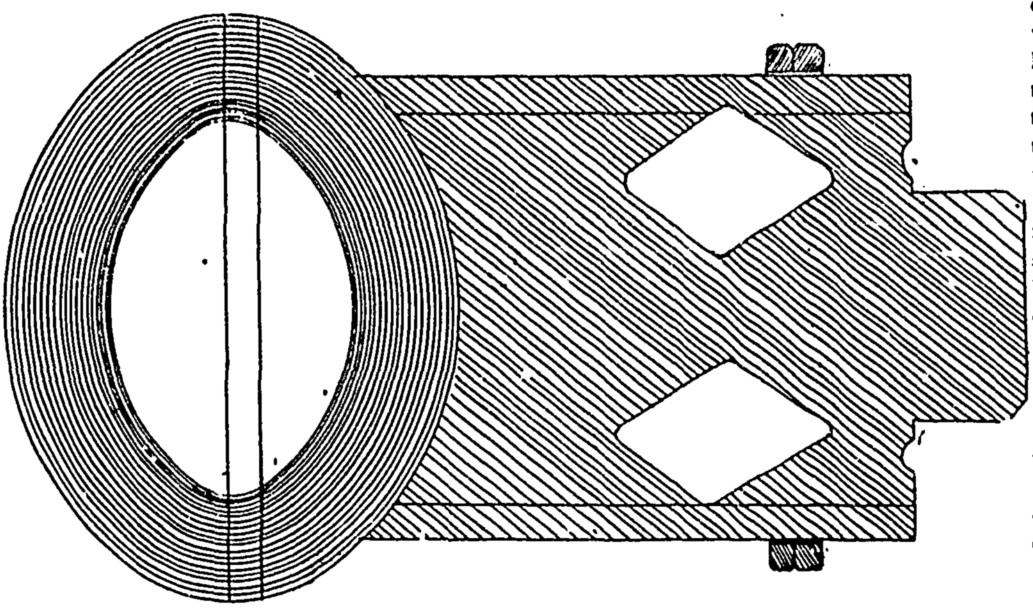


FIG. 2.—CHAMBER, SHOWING VALVE ATTACHED.

We need a rough-and-ready instrument that is portable, inexpensive, readily used, and at the same time reliable.

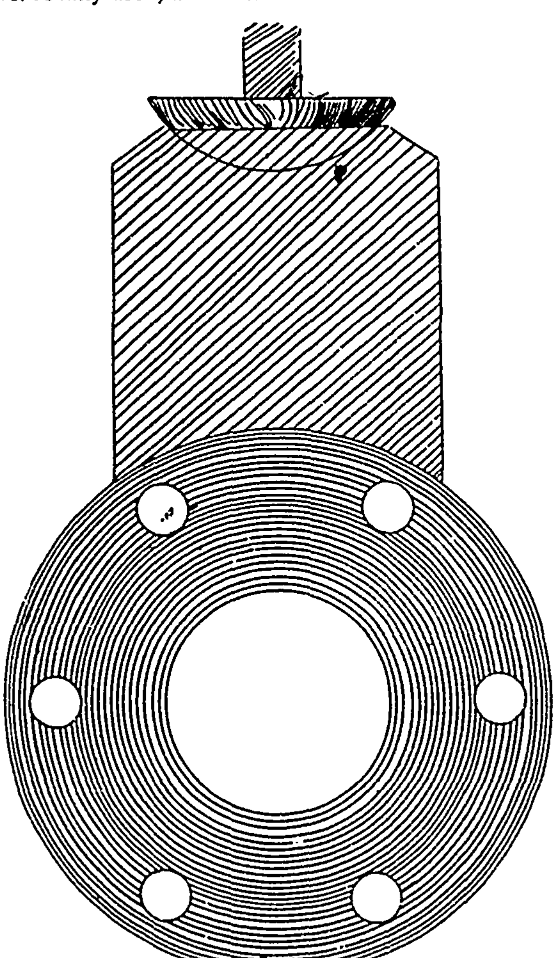


FIG. 3.—SHOWING COVER THAT BALANCES THE VALVE.

This we find in a friction-brake dynamometer, one of the many modifications of those illustrated by Mr. Wm. Worby Beaumont, in his paper on friction-brake dynamometers, read before the Institution of Civil Engineers, London, November 13, 1888, and published in 1889 in the Proceedings of the Institution.

Its construction requires only the use of a leather belt with a spring balance attached to one end, and a suitable weight to the other. The belt is to be thrown over the belt pulley of the motor, the spring balance is fastened to the floor base, or support of the motor to be tested, and the weighted end hangs pendant on the side of the pulley which, when in motion, will tend to lift the weight. When the motor is at rest, the strain of the weight should be read off the spring balance. This reading we will call *W*. When the current is switched on and the motor is run at a speed, the spring balance should again be read off, since the friction of the pulley on the belt will have a tendency to raise the weight; this reading we call *W'*. The difference between *W* and *W'* in pounds, multiplied by the circumference of the pulley in feet (including one-half the belt thickness on each side), and this by the number of pulley revolutions per minute will give the foot-pounds of mechanical energy, which can be compared with the electrical energy required to *produce it, in the usual manner.*

Thus, in a few minutes with the aid of a speed counter tachometer, a voltmeter and an ammeter, the efficiency of a motor can be determined, and its ability to do a desired amount of work ascertained at once, instead of being left to guess-work, as would be the case if more bulky or elaborate apparatus were needed.

It should not be imagined from these remarks that this form of dynamometer is applicable to small motors only; but it is evident that for testing larger machines where many horse-power have to be measured, the apparatus needs more elaboration, especially in the use of friction blocks, under the belt or pulley strap, *their lubrication, and the use of a dash-pot to steady the* brake when the motive power is irregular.

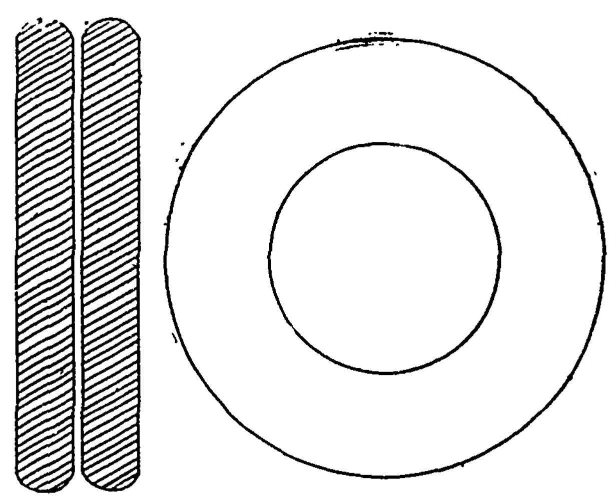


FIG. 4.—SHOWING THE WEIGHTS THAT FIT ON THE COVER, SHOWING TWO VIEWS.

But I need not enlarge on this, except to say that in these particulars, whether using steel strap, or leather belting with friction-blocks, or rope friction, the same care is needed as in the Prony brake to obtain correct readings.

* From a paper read by John Hoskin before the Franklin Institute.

A recent despatch from Kingston Ont., says a successful test has been made of a new diver's telephone invented by Mr. A. F. Smith, of that city.

The Dominion Parliament has passed a Bill incorporating the Anglo-Canadian Electric Storage and Supply Co. The projectors are: Francis Clemow, Charles H. Mackintosh, J. A. Gemmill, J. W. McRae, William McDougall, C. B. and C. C. Ray, of Ottawa, and Arthur Shippey and Henry Woodward, of London, Eng. The capital stock is placed at $50,000, and the headquarters of the company at Ottawa.

H. P. OF ENGINES.

TORONTO, July 23, 1891.

Editor ELECTRICAL NEWS.

In your July number C. W. Ross is again in print concerning horse power. From his statement that he is writing for the young engineer in the first of his letter, it is reasonable to expect he would make his case plain, but the whole letter is so mixed up that I would rather take my chances with formula and get my knowledge from them than from the muddle he has got the matter into. The young engineer knows that 33,000 lbs. raised 1 ft. high or moved through 1 ft. of distance in one minute is equal to or the equivalent of 1 horse power. This rule he applies to all forms of calculation of power; it does not matter to him what the immortal Watt concluded a horse actually did accomplish. It is not even necessary that he should know by what means the rule was established. His natural ideas of the application of power to work will show him that he can accomplish the same amount of work by making the load lighter and moving it farther per minute. The statement Mr. Ross makes, and which is printed in italics, says that a h. p. is a power that can raise 33,000 lbs. 1 ft. in one minute travelling at the rate of 220 feet per minute. Now, what travels 220 feet per minute. Why, the horse, of course. Still, he is only moving the load at the rate of 1 foot per minute; this don't fit some way. The load moves as fast as the horse does, no matter what its weight is or what the speed he travels at. Still Mr. Ross tells us to use both 1 ft. per minute and 220 feet per minute in connection with his 33,000 lbs. If I tell my boy that Jim Johnson's horse is going 220 feet per minute and that he is pulling a load after him of 150 lbs.; that horse is exerting one h. p., because 220 feet × 150 lbs. = 33,000 foot pounds, which = 1 h. p. This would establish in the boy's mind what a foot pound is, and he would know that if the horse was very strong and a good puller and could draw 33,000 lbs. along one foot per minute, he would also exert just 1 h. p. A racehorse to go a mile in 2½ minutes travels at the rate of 2,100 feet per minute, and if he pulls a load of 16 lbs. after him, he is exerting a power to 1 h. p., *i. e.*, 33,000 lbs. 1 ft. in 1 minute. Our friend Ross will do far more to enlighten the young engineer if he drops the 220 foot business, and lets the speed that a *horse can work at* go to the dogs. Accept the formula as it is to-day used 33,000 lbs. × 1 ft. × 1 minute = 1 h. p. Let matters of experiment by Leslie or any other expert who was trying to find out what a horse could do go with the rest. The young engineer is not interested in knowing whether a horse can do more or less; all he needs to know is that formula, 33,000 lbs. × 1 ft. × 1 minute, is the standard of measurement for a h. p. as used to-day. When a man gets to know so much that he is splitting hairs over things that have no real bearing on the h. p. of a steam engine, he is not useful to the young engineer, or the old one either for that matter.

N. GINERE.

THE OTHER SIDE OF THE SUBJECT.

Editor ELECTRICAL NEWS.

DEAR SIR,—I am a good deal surprised, and I may say, pained, to observe the bigotry and intolerance manifested by your correspondents "Safety" and "S" in their letters in your last issue. Presumably, from the tenor of their remarks, they are of the elect. They only know how it should be done—no one outside of the charmed circle knows anything about it. Now I would like the president of the Canadian Association of Stationary Engineers to say honestly whether any single engineer has been refused admission because he did not know enough. As everybody who applied has been admitted, how comes it that members alone possess the concentrated skill and smartness of the country and no one else possesses any? If your correspondent "Safety" had been at all acquainted with the circumstances of the explosion on Dufferin street he would not have been quite so ready to make an exhibition of himself in condemning a man who probably knows more about an engine than he does with all his assumed virtue. I happened to be present at the little occurrence spoken of, and can give a complete and unqualified denial to the aspersions of "Safety." The boiler in question was in a wood enbuilding surrounded by large quantities of inflammable material in the shape of cut and split wood, slabs, etc. Everything was in perfect order, and the employees were preparing to leave for the night, when the roof was discovered to be on fire. Before word could be sent to the fire hall, the whole building and contents were in flames. The boiler being of the locomotive type and not covered by brickwork, soon began to feel the effects of the heat, and made steam rapidly. The safety valve was blowing furiously, and probably no harm would have been done, when suddenly the heavy beams of the roof fell down across the lever of the safety valve. There could only be one result, the boiler had to go, and it went; but to say the engineer was to blame, and go into a fine frenzy about incompetence, and so forth, either shows that "Safety" has been writing about something he was ignorant of, or was venting his spleen against an independent man who chooses to "hoe his own row" rather than equalize himself with the "good, bad and indifferent" components of the ring.

With regard to the letter of "S," I and others who have spoken to me about it, regard it as neither more nor less than brutal. It is well that "S" shelters himself under the wing of an initial, or it is probable the men whom he libels would take it out of his hide.

Both the writers I refer to (I say both out of courtesy, because it is evident they are one and the same person), prate about civic interference, and develop a wonderful tenderness for the public. Gentlemen (?), your philanthropy is misplaced; there is no soft civic snap for you. This town is governed quite enough already It is taxed and inspected almost to death. Mind your own business, and don't interfere with better men than yourselves, because they don't see fit to join your blackmailing Mafia, or you may find yourselves strung up to the lamp post of public opinion, and your boasted certificates hung up with you.

Mr. Editor, I must apologize for taking up so much of your space, but the gross misrepresentations and animus of the two letters was too evident to pass over in silence.

Yours etc.,

R.

TORONTO BRANCH NO. 1, C. A. S. E.

Editor ELECTRICAL NEWS.

DEAR SIR,—At the last meeting of Toronto Branch No. 1, C. A. S. E., held in Shaftesbury Hall, on Friday, July 10th, the officers elect for the ensuing year were installed by Bro. past president A. M. Wickens, the only change in the list being that owing to the retirement of Bro. W. Reverley, who has removed to Mimico, Bro. Edward Phillips was appointed to succeed him as financial secretary, and Bro. Butter was appointed to succeed Bro. J. Queen as conductor.

After the two newly elected officers had been installed, they were called on to say a few words, which they did, thanking the members of the Association for the honor done them in placing them in positions of trust, and promising to endeavor to fill the positions they had been elected to with credit to themselves and to the best interests of the Association, and to do their utmost to increase the membership and place the Toronto society in a position second to none on this continent.

Bro. A. M. Wickens then called on President A. E. Edkins for a few remarks on entering his second term of office.

Mr. Edkins thanked the members for the honor bestowed upon him, in thus for the second time electing him to fill the highest office in the gift of the Association, and said that when about a year ago he was elected to the office he was conscious of very serious misgivings as to his ability to properly fill the position. He was, however, glad to know that during his year of office he had succeeded in filling the position so satisfactorily. After paying a deserved tribute to the Financial Secretary, he stated that during the past year there had been admitted over twenty new and very desirable members, and particularly requested each member to make an effort during the coming year to materially increase the membership, which was not as large as it should be in a city such as Toronto. If each member would bring in one new member, what a grand showing it would be at the end of the year.

He was glad to know that although at times some of the members got a little heated in the discussions at the meetings, yet they soon cooled down and everybody again became good friends. This was as it should be; for it could not be expected that all would be of the same opinion. When anything came up concerning the good of the Association as a body, the members could always be depended upon to stand shoulder to shoulder.

So long as this policy was followed, the Association would prosper in the future as in the past.

In conclusion he thanked the officers and members for the excellent support given him during his term of office, and hoped that the same would be accorded him during the term they were about entering upon, assuring them that he would at all times endeavor to do his duty.

Bro. W. Sutton, who was re-elected Treasurer, next made a few remarks, and presented his yearly report, which showed a substantial balance in the bank to the credit of the Association.

Bro. W. Lewis, who was re-elected Vice-President, thanked the members for re-electing him, and said he would continue to try and do his duty.

Bro. W. Blackgrove has held the position of Recording-Secretary for the past three years, and has just been re-elected by acclamation. Bro. Blackgrove makes the best Secretary the Association ever had, and can point with pardonable pride to the fact that during his years of office not one omission or mistake has occurred in the minutes. The Association is studying its own interest by keeping him in the position which he is so well qualified to fill. The office of Recording-Secretary is no sinecure; there is any amount of work attached to it, but Bro. Blackgrove is a "hustler" (especially when he is running in a 100 yards race for a fine mantel clock).

Bro. C. Mosely was re-elected as Door-Keeper, and will continue to guard the wicket as zealously as in the past.

The Association is looking forward to a year's solid good work, and if it continues to prosper as it has done, it will before long become the leading stationary engineers association in America—and that without becoming part of the U. S. either.

By the way, I hear that some of the marine engineers are grumbling about the Marine Association not being any good. Why don't they join us? It would do them good. They would find that instead of our boys not being willing to tell anything they know in the Association, there are often two or three trying to get at the black board at once. And yet we are "only stationary engineers, anyway, and don't amount to a great deal," as a marine man said one day. Well, perhaps we don't, but we are in a fair way to 'get there." If a man is an "engineer" (which few of us are in all the word implies), it does not matter whether he is a marine, stationary, or what.

Yours, &c.,

"SAFETY."

STRENGTH OF BOILERS.

THE tendency of the pressure within a steam boiler is to force the material into the shape of a perfect sphere. Experiments have been tried by making models of various shapes of steam boilers of an elastic material, such as rubber, and then pumping air inside so as to produce pressure of any desired amount and noting the effect in altering the shape. By this plan the theoretical calculations have been tested and proved to be correct.

In a cylindrical boiler the ends, if made hemispherical, will require no stays, but if flat, must be stayed in order to enable them to resist the same pressure as the cylindrical part. In a cylindrical boiler of any given diameter, the strain tending to rupture the shell depends upon the diameter and the pressure, and is found by multiplying the pressure and diameter together. In making such calculations, it is absolutely necessary that the same standard of units be used. If the pressure be taken in pounds per square inch, then the diameter must be measured in inches, and it will be found convenient to assume one inch as the length of the strip of the shell, the strain upon which is to be calculated.

Let the shell be sixty inches in diameter, and the pressure one hundred pounds per square inch, what is the strain produced tending to rupture the cylindrical shell? Sixty pounds × one hundred is six thousand pounds. This, however, bears equally on two sides of the shell, tending to break the cylindrical hoop into two equal parts; hence the strain on each side is three thousand pounds. Had the cylinder been thirty inches diameter instead of sixty, the strain produced by the same pressure would only have been one-half that amount. It is important here to consider what is meant by a pressure of 100 pounds per square inch. It is 100 pounds and the pressure of the atmosphere, or about 115 pounds, but as the pressure of the atmosphere is on the outside as well, it is usually left out of the count.

Experiments are now being made with a steam boiler formed of one shell within the other. Each contains its own supply of water, and has its own safety valve and connections. In the inner one the steam pressure used is 500 pounds per sq. inch, in the outer one it is 200 pounds. By this means the pressure producing strains on the plates of the inner one is reduced to 300 pounds, and as it is smaller in diameter than the outer shell, the total strain on each shell may be made the same.

In the boiler sixty inches diameter 100 pounds pressure as shown on the steam guage was shown to produce a strain of 3,000 pounds on each inch of the length of the shell. What is there to resist this? The thickness of the plate, or rather the amount of metal left after the rivet holes have been made in it.

In single rivetted seams the strength may be taken at one-half that of the solid plate, and in double rivetted seams at seven-tenths of the solid plate. If the plate be three-eighths of an inch thick and the strength of the plate 60,000 pounds per square inch, then the strength of the double rivetted joint will be $60{,}000 \times \frac{3}{8} \times \frac{7}{10} = 15{,}750$. The strain was found to be 3,000, and the strength to resist it 15,750, or a little more than five times. This is a very common difference and is called the factor of safety. It is common to have in new boilers a factor of safety of 6, or 5 or sometimes 4. The necessity for having such a difference between the strength and the strain arises from imperfections in workmanship, and uncertainty as to the actual strength of the particular plates.

ENGINEERS' PICNIC.

THE C.A.S.E. picnic at Oakville, on July 1st, proved to be an unqualified success. Notwithstanding the fact that in the early morning there was a regular downpour of rain, and a very gloomy outlook for the day, Toronto engineers and their friends turned out about 350 strong. With abundance of provisions and good feeling, all were bound for a good time, and their expectations were fully realized.

The long list of competitions was carried out to the letter. Steam was let on at three o'clock a very late start owing to the weather. Owing to the high pressure carried and the fact that the governor worked to a charm, the bottom of the programme was reached without a hitch of any kind.

The first event was a 100 yards race, members only, the prizes for which, a shaving set, a caddy of coffee and a back saw, were won by Bros. Chillman and Bellington, of Hamilton, and Bro. Hughes, of Toronto, in the order named.

100 yards race, open to B—1st, Dowling, \$3; 2nd, Agerst, \$2.

Running long jump—1st, Bro. Bellington, 1 ton coal, 2nd, Bro. Chillman, 1 pocket knife, 3rd, Bro. Butter, knife sharpener.

75 yards, old man's race—1st, Bro. Sutton, engineer's oil set, 2nd, Bro. Gilchrist, spring mattress, 3rd, Bro. Carter, Hamilton *Times*, one year.

100 yards boys' race—1st, Finlay, \$1, 2nd, Boyle, 50 cents.

Tug of war—Hamilton vs. Toronto Prizes, silver cup and box of cigars, won by Toronto in two straight pulls.

50 yards girls' race—1st, Miss Williams, pair vases, 2nd, Miss Irving, toilet soap.

Standing high jump—1st, Bellington, rubber coat; 2nd, Anderson, hat, 3rd, W. Lewis, knife sharpener.

Smoking race—1st, Bro. Caffrey, Meerchaum pipe, 2nd, Bro. Tarranto, caddy tobacco, 3rd, Bro. Wilcox, briar pipe.

Standing broad jump, open to all—1st, Mr. White, ton of coal, 2nd, Bro. Bain, bag of flour, 3rd, ———, knife sharpener.

75 yards race, engineers' wives—1st, Mrs. Bain, silver water pitcher, 2nd, Mrs. Moseley, silver butter dish, 3rd, Mrs. Marshall, Hamilton *Times*, one year.

Best waltzers—1st, H. Graham and lady, silver cruet stand; 2nd, Mr. and Mrs. Witty, lady's fan, 3rd, Mr. Benwell and lady, pound of tea.

Quarter mile race, members only—1st, Bro. Moseley, household bank, 2nd, Bro. Nichol, copy of S. P. Thompson's "Dynamo Machinery", 3rd, Bro. Miller, 40 yards cotton duck.

Putting shot, open to all—1st, J. O'Rieley, ton of coal, 2nd, W. Brush, box of soap; 3rd, W. Leith, knife sharpener.

Shoe race—Miss Waterson, 1 pair boots; 2nd, Miss Fassants, bird cage.

Engineers' young ladies race—1st, Miss Everett, G. P. clock, 2nd, Miss Nichol, Hamilton *Spectator*, one year, 3rd, Miss Fassants, three bottles of pickles.

Judges and starters' race—1st, Mr. Johnson, 1 ton of coal, 2nd, Bro. Moseley, ½ ton of coal, 3rd, Mr. Harrison, knife sharpener.

Consolation race—1st, W. Blackgrove, mantel clock, 2nd, Hamilton, ½ cord of wood; 3rd, W. Terry, monkey wrench.

The intention was to have had a game of baseball, Hamilton vs. Toronto, but a shower stopped the game at the end of the first innings, with the score in favor of Hamilton.

The wet morning prevented many from attending. As it was, this was the largest gathering of engineers ever got together in Canada. All present expressed themselves as satisfied with the day's outing, and the picnic bids fair to become an annual one.

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OUR SPECIAL NUMBER.

SATISFACTORY progress is attending the arrangements for the publication of the special number of the NEWS on 1st September in connection with the Electrical Convention in Montreal. The number will contain special articles and illustrations of great interest. Judging by the demands of American manufacturing and supply houses for advertising space, and the fact that representatives of some American houses have recently visited Canada in person, the importance of the Canadian market for electrical goods is being properly appreciated across the line, and a determined effort made to secure as much of it as possible. We would like to see Canadian manufacturers and dealers properly represented in our Convention number, and for this reason we point out the fact that those who fail to secure advertising space at once need not complain if a week or two later they should find that all the best positions have gone to their wide-awake American competitors. A word to the wise is sufficient.

THE convention of the N. A. S. E. opens at Omaha, Neb., on the first Tuesday in September. It is expected that at this meeting the question of changing the name and constitution of the Canadian Society for the purpose of making it international will be considered.

WE print in our correspondence column a communication signed "R," having reference to two letters which appeared in our last issue. It may be that "R" shows a little of that intolerance which he so unsparingly condemns in others, but we think that the engineers may find in it at least some food for serious thought.

A SEVERE blow has been struck at the prosperity of the natural gas industry on the Niagara peninsula by the action of the United States Board of General Appraisers in levying a 10 per cent duty on natural gas generated and exported by the Provincial Natural Gas and Fuel Co. of Ontario to the Natural Gas and Fuel Co., of Buffalo. The company will probably require to turn more of its attention in future to Canadian cities.

THE Federal Telephone Co., of Montreal, has been absorbed by the Bell Telephone Co. The Montreal City Council should now follow in the footsteps of the City Council of Toronto by placing such restrictions upon the Bell company as will insure fair treatment to the citizens. If this is done, the placing of the telephone business in the hands of a single company should prove a source of public satisfaction.

THE yearly meeting of the Executive Board of the C. A. S. E. will be held in Toronto on Tuesday, Sept. 8th. Delegates from all the Associations are expected, and the work of perfecting the organization will engage their attention. The work of the past year will be reviewed, and an effort made to insure greater progress in the future. Engineers throughout Canada should take an interest in these meetings, the object of which is to assist by all legitimate means in raising the status of the business.

IN pursuance of the Engineers' Act, passed at the last session of the Ontario Legislature, the Board of Examiners are nearly ready to examine and grant certificates to engineers. The necessary printing is now in hand, and as soon as completed, the examiners can get to work. Any engineer wishing information on the subject, can obtain it by addressing Mr. J. A. Wills, Custom House, Toronto; A. M. Wickens, *Globe* office, Toronto; or Robt. Dickinson, Electric Light Station, Hamilton. We are informed there are a great many applicants waiting the opportunity to be examined.

THE elaborate, secret, and costly experiments in human butchery that have recently taken place in a New York prison appear to have been more or less successful. Whether "the game is worth the candle," however, is another matter. We are inclined to the belief, previously expressed by us, that it is entirely an unnecessary waste of thunder. A good dose of cyanide or prussic acid would do the business quite as effectively and be wonderfully cheap and inexpensive in comparison. But we also incline to the belief that the old-fashioned rope is quite good enough to perform the happy dispatch for men of such brutal instincts as the subjects recently devoted to the "electrocutioner's" art.

IT is unfortunate that the date set for the convention and exhibition of electrical appliances in Montreal will conflict with that of our own Industrial Exhibition in Toronto. We understand the date of the Montreal convention has been fixed for the 8th, 9th and 10th of September, and for the exhibition there, the 7th to the 16th of the same month. The Toronto Exhibition is billed from the 7th to the 19th of September. As, however, the second week of the Toronto Industrial is usually considered the best, visitors to the convention will be enabled to visit it on their return from Montreal. It will be somewhat more of a task to those who wish to exhibit at both places, but greater difficulties than this have been overcome by enterprising electrical men.

IN order to properly appreciate the advantages conferred by the electric light, it is only necessary that one should spend a night in a town to which this modern illuminant is a stranger. Bracebridge, Muskoka, where the writer landed one night recently, is such a town. An attempt has been made to light the streets by planting coal oil lamps at a few of the principal street corners. It was impossible to observe the results, as on the night in question the lamps remained unlighted in the expectation that the moon would give a more satisfactory light and at less expense to the municipalty. This expectation not being realized, the town was wrapped in Egyptian darkness. Persons unacquainted with the place ventured out at the risk of falling at every step. It was impossible to discern the features of persons one might meet. Altogether, the effect upon those accustomed to move about beneath the penetrating rays of the electric lamp, was gloomy in the extreme. No town of the importance of Bracebridge should be without electric street lighting. It adds wonderfully to the comfort of the citizens, tends to increase population, and maintains the town's reputation for progressiveness. The water-fall at Bracebridge we imagine would provide effective and economical power for the operation of an electric plant. It is the more surprising therefore, that the advantages presented have not been made available.

A CURIOUS illustration of the sensitiveness of modern scientific instruments was afforded some time back in Toronto when it was noted by Prof. Carpmael, at the Observatory, that some of his apparatus was influenced in a remarkable manner at certain times of the day. On thinking the matter over, he came to the conclusion that it was the current of electricity in the street lighting wires that was the cause, although the nearest wire to the observatory was on Bloor street, nearly a mile away. To prove the matter, he made a note of the times of the influence, which on comparison with the city time schedule fo. starting the lights, was found to exactly agree. It is now found that similar instruments to Mr. Carpmael's, namely, those for measuring earth currents and magnetic disturbances, located at Greenwich Observatory, near London, have been found to be thrown into vibration by the passing of trains on the Stockwell Electric Railway. The railway tunnel is over two miles from the nearest earthplate connected with the observatory, but the currents set up are sufficiently strong to make very distinct deflections. The times of the interference being exactly the same as those on which the trains are running, leave no doubt as to the cause of the disturbance. Fortunately, Mr. Carpmael says, the cause of the disturbance being known, it can be allowed for without affecting the general results obtained from the instruments.

AT the request of a number of managers of electrical companies, the publisher of the ELECTRICAL NEWS recently addressed a circular to the owners of electric plants in Canada asking an expression of their opinion regarding the desirability of organizing a Canadian Electrical Association. They were also requested to state whether they would be willing to attend an informal meeting in Toronto on September 17th to consider the subject. The replies received are almost unanimously in favor of the proposition, and so many have declared their willingness to attend a meeting, that it has been thought well to announce that the meeting will take place in this city on the date mentioned. Particulars as to place of meeting, etc., will be given in the September number of this journal. Meanwhile, every person connected with the electrical interests of the country is urged to be present on the occasion.

IF present indications are reliable, and they should be, there is prospect of a great time ahead for electricians and the electric interest generally at the forthcoming convention to be held in Montreal. The date of opening is fixed for the 7th of September, and the citizens of Montreal are even now working with might and main on the details of a royal Canadian welcome which is to be given to the National E. L. Association. There is to be a conversazione arranged for the members; excursions upon and around the mountain; the harbor commissioners will provide a steamboat with the regulation Indian pilot for a run of the Lachine Rapids; the municipal authorities are sparing no pains to do the visitors proud. It may be asked, amidst all these arrangements for the pleasure and entertainment of the visitors, where does the Convention come in? There will no doubt be found a sufficient corner or two to work in the necessary business and instructive features. Not the least among these latter we hear, is to be an illustrated lecture by the famous young electrician, Nikola Tesla, on his recent discoveries in lighting by high frequency alternating currents. This will be a treat to the Canadian electrician such as does not come within his reach every day. In addition to all this, the Electrical Exhibition is expected to be the best ever held in connection with the Association. All the available space has been taken up, and the display of machinery and appliances will be most complete and interesting. We strongly recommend our electrical brethren in Canada to pay a visit to Montreal at some time during the convention and see for themselves how it is done, and be enabled to decide on the advantages of a local association of electric lighting interests, which, while in no sense competing with the wider one of the United States, would be able to conserve the interests of the distinctively Canadian branch of the electric lighting industry.

THE MONTREAL CONVENTION.

A MEETING of the Executive Committee of the N. E. L. A. was held in the Windsor Hotel, Montreal, on Tuesday, July 21st, at which there was present Prof. McLeod, Mr. F. Fairman, Mr. F. R. Redpath, Mr. W. H. Laurie, Mr. John Kennedy, Mr. J. A. U. Beaudry, Prof. Cox, Mr. W. S. McFarlane, Mr S. C Stevenson, Mr. J. S. Shearer, Mr. E. C. Arnoldi, Mr W. E. Christie and others.

Owing to the absence of the chairman it was proposed by Mr. Stevenson that Mr. Kennedy should take the chair. Carried.

The secretary read the minutes of the last meeting, which were adopted.

Mr. Kennedy, as to the arrangement with Harbor Commissioners, reported that the matter was not closed, and further delay was asked. As to the visits to the Canadian Pacific and Grand Trunk railways, he was not prepared to report. Through error it was stated in the newspapers that arrangements had already been made on the invitation of the railways, but nothing of the kind had been done. The Board were to fix that.

Mr. Christie reported that a lacrosse match could be arranged, but the day was wanted to be known that would be suitable. It was also desired to print a programme, the object of which was that once the day was settled for the lacrosse match it would not conflict with the exhibition. A suggestion was made at the same time to draw up a small committee to form a programme.

Mr. Laurie stated that there were several committees already arranged.

The secretary stated that the business aarangements must come first, and the entertainments must be fitted in.

Mr. Kennedy was not in a position to say that it was feasible to carry out the proposal to run the rapids and visit the railway workshops.

Mr. Stevenson suggested that the various sub-committees should report to the General Committee.

Mr. Beaudry asked that the lacrosse match be arranged at once, but it was found impossible to do so.

Mr. Fairman, for the Dominion Bridge Works, stated that a meeting had been held at his office. Messrs. Ives, Cooper and Beaugrand undertook to see the Canadian Pacific and Grand Trunk railways for a guarantee and subscription, and Mr Ives was to visit St. Francois Xavier and St. James street business people. He could only report progress, and say that they had so far a guarantee amounting to about $1,000.

Mr. Stevenson, for the "Forest and Stream Club," had no definite report to make.

Prof. McLeod, regarding the proposed expenditure in connection with the conversazione, reported having looked over the grounds, and proposed to unite the Molson Hall and the Redpath Museum into one, as the accommodation thus provided would be required. He also proposed to have a large tent and to unite that with the Redpath Museum, the tent being used for refreshments and as an outdoor place where the people could circulate more freely. The size of the tent proposed would be about 120 feet long by 140 feet wide with wings. The canvass required would cost about $150, and carpentry $50 more. It was estimated that the cost of music would be somewhere in the neighborhood of $50. No estimate for refreshments was as yet obtained. He considered that provision should be made for nearly 1,000 guests, and wanted the views of the Committee.

Mr. Christie thought the estimate should be about $400. The secretary stated the amount would probably be about $650.

A motion was made by Prof. McLeod, seconded by Mr. S. C. Stevenson, that Messrs. Beauvais, Carroll and Corriveau be named a committee to draft a programme.

Mr. Kennedy stated that at the last meeting it was suggested not to have too many names on the committees, and the secretary said that a number of the names were not attending, and it might be thought desirable to reduce same.

The secretary stated that a number of gentlemen throughout the city to whom cards were sent had not attended, and it was thought best to strike a number of the names off the sub-committees. A proposal was made to put these names on the general reception committee, which was done, and also that no notices were to be sent to any but the working committee, which was carried.

Mr. Christie desired to know the limit of the Executive Committee, and was informed that it was from 20 to 30.

The exact date of the convention was from the 7th to the 16th September.

A meeting of the Citizens' Executive Committee was held in the Windsor Hotel on the evening of Tuesday, July 28th. There were present Prof. Bovey, in the chair; Messrs. F. R. Redpath, J. Carroll, J. S. Shearer, J. Kennedy, Linnell, Laurie and Toms

Prof. Cox asked to be relieved from the duties of his position as secretary of the committee, on account of his having been called to England on important business. The resignation was not, however, accepted, but Mr. John Carroll was appointed as joint secretary.

After discussing a variety of subjects connected with the details of the forthcoming convention, the committee adjourned until the 3rd inst.

Subsequently a meeting of the sub-committee on exhibits was held, Mr. F. R. Redpath presiding, when the following resolutions were passed:

"That the secretary be instructed to write to Mr. Dwight, of the Great Northwestern Telegraph Co., regarding pole privileges in connection with those of the Bell Telephone Co., for carrying the wires from McGill University to the Victoria rink."

"That Mr. Corriveau and Mr. Carroll be appointed a committee regarding the decorations for the rink, and report at the next meeting."

A letter was received from Mr. Gulick, president of the Exhibition Committee in New York, reporting that considerable progress had been made in the work of the allotment of space. A number of new applications for space were received. Mr Carroll was appointed secretary of the sub-committee, in the place of Mr. F. Nicholls, resigned.

A meeting of the Executive Committee is being held in New York to-day (1st inst).

It is the intention of the Montreal press to appoint a committee to receive the visiting pressmen. A meeting to consider the matter will be called at once.

SAFETY VALVES—THEIR HISTORY, ANTECEDENTS, INVENTION AND CALCULATION.

By Barnet le Van.

It will be seen from the above that the weights act at two different points, and that there are three levers to be considered:

First. The long lever L of the weight W, which is the distance from the weight W to the fulcrum *f*.

Second. The lever *x*, due to the weight *w*, of the lever arm *a*, valve *v*, and stem *s*, which is the distance from the centre of gravity *g* to the fulcrum *f*.

Third. The short lever *l*, which is the distance from the fulcrum *f* to the centre of the valve stem *s*.

The centre of gravity *g*, of the lever arm *a*, is found by balancing it over a sharp edge, with the valve *v* and stem *s* attached at the proper distance *g* from the fulcrum *f*. The weight *w* of the lever arm *a*, valve *v*, and stem *s*, multiplied by the distance *x* from the centre of gravity *g* to fulcrum *f*, gives the *momentum*, as before stated, of the lever arm *a*, which is a constant quantity in the graduations of the lever arm *a*, for different pressures of steam.

The form of the lever arm *a* affects the location of the centre of gravity *g*; but when this centre is known, the shape of the lever arm *a* does not affect the static momentums. The area and weight can be expressed in any unit of weight, as well as the levers in any unit of length. For greater accuracy, the centre of the fulcrum *f*, weight W, and valve stem *s*, connections to lever arm *a* should be in straight and horizontal lines; and in finding the centre of gravity *g*, the valve *v* and stem *s* must be in their natural position when the lever arm *a* is balanced over a sharp edge, in order to find the centre of gravity of the system.

The action of the combination is readily understood by the illustration—namely, that the two static momentums, weight *w*, multiplied by the long lever L, added to the momentum *w x* of the lever arm *a*, valve *v*, and stem *s*, multiplied by the distance *x*, from the centre of gravity *g* to fulcrum *f*, act opposite and must be equal to the momentum of the force F of the steam pressure *p*, multiplied by the area A of the valve *v*, and this product by the length of the short lever *l*, or the static momentums. The algebraical expressions of the foregoing may be set up as follows:

$$W\,L + w\,x = A\,p\,l \qquad \text{.......... 1}$$

Or, in words: The area A of the valve *v*, multiplied by the steam pressure *p*, per square inch, and this product by the length of the short lever *l*, equals the weight W, multiplied by the length of the long lever L, plus the weight *w* of the lever arm *a*, valve *v*, and spindle *s*, multiplied by the distance *x* from the fulcrum *f*, to the centre of gravity *g*, or the momentum *w x*, of lever arm *a*. That is to say, the static momentums are in equilibrium.

To find the weight W on a given safety valve when the steam pressure *p* is known, and all the other dimensions known:

$$\text{Weight } W = \frac{A\,p\,l - w\,x}{L} \qquad \text{.......... 2}$$

Rule.—multiply the area A of the valve, in square inches, by the steam pressure *p*, in pounds per square inch, and this product by the length of the short lever *l*, in inches; from this last product subtract the momentum *w x*, of the lever arm *a*; divide this remainder by the length of the long lever L, and the quotient will be the weight W in pounds required.

To find the length of the long lever L, the area A of the valve, the steam pressure *p*, and all the other dimensions being known:

$$\text{Lever } L = \frac{A\,p\,l - w\,x}{W} \qquad \text{.......... 3}$$

Rule.—Subtract the momentum *w x* of the lever arm *a* from the area A of the valve in square inches, multiplied by the steam pressure *p* in pounds per square inch, and this product by the length of the short arm *l*, and divide this remainder by the weight W in pounds; the quotient will be the distance in inches from fulcrum *f* to place the weight W.

To find the pressure *p* per square inch at which a safety valve will blow off, the weight W, and all the other dimensions being known:

$$\text{Pressure } p = \frac{W\,L + w\,x}{A\,l} \qquad \text{.......... 4}$$

Rule.—To the momentum of the lever arm *a*, add the product of the weight W, multiplied by the length of the lever arm L; divide the sum by the product of the area A, multiplied by the length of the short lever *l*, and this quotient will be the steam pressure *p* in pounds per square inch.

To find the area A in square inches, the weight W, and steam pressure *p*, and all the other dimensions being known:

$$\text{Area } A = \frac{W\,L + w\,x}{p\,l} \qquad \text{.......... 5}$$

Rule.—To the momentum *w x*, of the lever arm *a*, add the product of the weight W, multiplied by the length in inches of the lever L: this sum, divided by the product of the steam pressure *p* in pounds per square inch by the length of the short lever *l*, will be the area A in square inches.

To find the weight *w* of the lever arm *a*, valve *v* and stem *s*, the area A in square inches, and steam pressure *p*, and all the other dimensions being known:

$$\text{Weight of lever } w = \frac{A - p\,l - W\,L}{x} \qquad \text{.......... 6}$$

Rule.—Subtract the product of the weight W, multiplied by the length of lever L, from the product of the area A multiplied by the steam pressure *p*, and this product by the length of the short lever *l*; this remainder, divided by the lever *x*, or distance of the centre of gravity *g* from fulcrum *f*, the quotient will be the weight of lever *a*, and valve *v* and stem *s*.

To find the distance *x* in inches from the centre of gravity *g* to fulcrum *f*, the area A in square inches, of the valve, the steam pressure *p* in pounds per square inch, and all the other dimensions being given:

$$\text{Distance } x = \frac{A\,p\,l - W\,L}{w} \qquad \text{.......... 7}$$

Rule.—Multiply the weight W by the length of the lever L; from this product subtract the product from the area A, multiplied by the steam pressure *p*, and this product by the length of lever *l*; divide the remainder by the weight *w*, of the lever arm *a*, valve *v* and stem *s*.

Having given the levers L, *l*, and *x* the area A (D² × 0.7854), steam pressure *p*, and the weight *w*, the weight W is calculated by formula 2.

Example 2.—A safety valve has a diameter of D=2 inches, and the lever to a pressure of steam *p*=80 pounds per square inch, with the following dimensions:

A=area of valve D=2 inches (2×2×0.7854) 3.1416 L=long lever in inches 30
l=short lever in inches 4
x=distance of centre of gravity *g* 15
w=weight in pounds of lever arm *a*, valve *v* and stem *s* 6
p=steam pressure per square inch in pounds 80

What will be the weight required?

$$\text{Formula 2: } W = \frac{A\,p\,l - w\,x}{L}$$

$$W = \frac{3.1416 \times 80 \times 4 - 6 \times 15}{30} = 30.5 \text{ pounds.}$$

Example 3.—Suppose a safety valve to be of the following dimensions, at what distance L from the fulcrum *f* must the weight W be placed to carry a steam pressure *p*=50 pounds per square inch?

A=area of valve D=3 inches (3×3×0.7854) 7.068
p=steam pressure per square inch in pounds 50
l=short lever in inches 4
w=weight of lever arm *a* valve *v* and stem *s* in pounds 10
x=distance of centre of gravity *g* in inches 18
W=weight in pounds 50

$$\text{Formula 3: } L = \frac{A\,p\,l - w\,x}{W}$$

$$\text{Lever } L = \frac{7.068 \times 50 \times 4 - 10 \times 18}{50} = 22.6 \text{ inches.}$$

Example 4.—A safety valve having the following dimensions, at what pressure *p* per square inch will it blow off?

L=length of long lever in inches 30
l=length of short lever in inches 3
W=weight in pounds 50
w=weight of lever arm *a*, valve *v* and stem *s* 12
x=length from fulcrum *f* to centre of gravity *g*, in inches 15
A=area of valve in square inches 7

$$\text{Formula 4: } p = \frac{W\,L + w\,x}{A\,l}$$

$$\text{Steam pressure } p = \frac{50 \times 30 + 12 \times 15}{7 \times 3} = 80 \text{ pounds.}$$

Example 5.—The following dimensions, and the steam pressure *p* per square inch to be carried, to find the area of valve A?

L=length of long lever in inches 30
l=length of short lever in inches 4
W=weight in pounds 30
w=weight of lever arm *a*, valve *v* and stem *s*, in pounds 12
x=distance from fulcrum *f* to centre of gravity *g*, in inches 10
p=steam pressure in pounds per square inch 40

$$\text{Formula 5: } A = \frac{W\,L + w\,x}{p\,l}$$

$$\text{Area } A = \frac{30 \times 30 + 12 \times 10}{40 \times 4} = 6.375 \text{ square inches.}$$

or about 2¾ inches in diameter.

Example 6.—A safety valve of the following dimensions, to find the weight of the lever arm *a*, valve *v* and stem *s*, the distance *x* and steam pressure *p* being given.

A=area of valve in square inches 2
p=steam pressure in pounds per square inch 80
L=length of long lever in inches 20
l=length of short lever in inches 1.5
W=weight in pounds 10
x=distance from centre of gravity *g* to fulcrum *f* in inches 10

$$\text{Formula 6: } w = \frac{A\,p\,l - W\,L}{x}$$

$$\text{Weight } w = \frac{2 \times 80 \times 1.5 - 10 \times 20}{10} = 4 \text{ pounds.}$$

Example 7.—A safety valve of known dimensions, given to find the distance *x* from centre of gravity *g* to fulcrum *f*, in inches.

A=area of valve in square inches 20
p=steam pressure in square inches 30
L=length of long lever in inches 40

l=length of short lever in inches 4
W=weight in pounds 50
w=weight of lever arm a, valve v and stem s in pounds 20

$$\text{Formula 7}: x=\frac{A\,p\,l-W\,L}{w}$$

$$\text{Distance } x=\frac{20\times30\times4-50\times40}{20}=20 \text{ inches.}$$

THE GRADUATION OF SAFETY VALVE LEVERS.

For great accuracy in finding the centre of gravity g, the weight of valve v and stem s should be weighed with the lever arm a; and they also should be placed on the lever at their proper distance from fulcrum f when the lever arm a is balanced over a sharp edge. As before stated, the momentum wx of the lever is found by multiplying the weight of lever arm a, valve v and stem s by the distance x from the fulcrum f to the centre of gravity g, which is a constant quantity in the graduation of the lever for different pressures of steam.

Example 8.—A safety valve of the following dimensions, the lever to be graduated from 30 to 80 pounds to the square inch.

First find the weight W required for a steam pressure of 80 pounds to the square inch, which number is to be marked on the lever 30 inches from the fulcrum f.

A=area of valve in square inches 3
p=steam pressure in pounds per square inch 80
L=length of long lever in inches 50
l=length of short lever in inches 2
w=weight of lever arm a, valve v and stem s in pounds 4
x=distance from fulcrum f to centre of gravity g in inches 7.5

$$\text{Formula 2}: W=\frac{A\,p\,l-w\,x}{L}$$

$$\text{Weight } W=\frac{3\times80\times2-4\times7.5}{30}=15 \text{ pounds.}$$

The weight W required to balance steam pressure p=80 pounds to be placed on the lever L—30 inches from the fulcrum f.

Now find the long lever L, or at what distance from fulcrum f shall the weight W=15 pounds be placed to balance a steam pressure of p=30 pounds to the square inch.

$$\text{Formula 3}: L=\frac{A\,p\,l-w\,x}{W}$$

$$\text{Distance from fulcrum } f - L=\frac{3\times30\times2-4\times7.5}{L}=10 \text{ inches.}$$

Then measure off this distance L=10 inches on the lever arm a from the fulcrum f, and mark it with the number 30; divide the distance between the first and second positions of the weight into 80—30—50 equal parts, and number them from 30 to 80 consecutively. The lever is thus graduated for the required pressure of steam by 1 pound of difference per square inch.

The following method of calculating the weight area of safety valves is used by Morris, Tasker & Co., incorporated, of Philadelphia, furnished them by the late Robert Briggs (see Fig. 11).

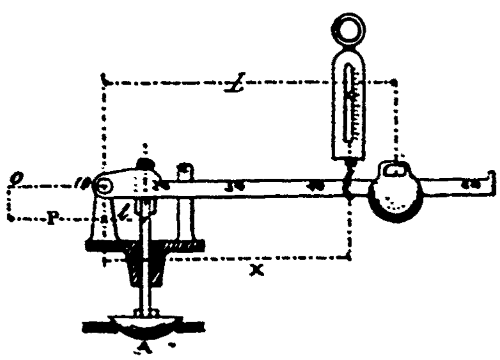

FIG. 11.

First. Multiply the area A of the valve v in square inches ($0.7854\ D^2$) by 10 pounds (or whatever unit of pressure per square inch is taken to form a division of the lever).

Second. Multiply the short lever l, in inches by the area A in square inches and the 10 pounds (the divisions of the lever), which will give 10 A l, which will equal the *momentum* of the pressure on the valve at 10 pounds pressure p, per square inch on the short lever l.

Third. Divide the momentum 10 A l by the weight W, having assumed a weight W which it is desirable to use; the result is the length in inches of each division of the lever which will indicate 10 pounds pressure p on the valve surface.

Fourth. Remove the weight W from the lever arm, hook on a spring balance at some ascertained distance x, in inches from the fulcrum f, and lift the lever arm, valve v and spindle s from its sit by the balance. Take the weight w indicated and multiply it by the distance x, and the result will be the *momentum* of the weight W, and the result will give the length of an imaginary line P, behind the fulcrum f, on the end of which if the weight W were hung it would balance the lever arm, valve v and spindle s.

Fifth. The end of the line P we will call O=zero, as a new point from which the first division commences, and the following divisions are to be carried along the lever arm, as shown on the drawing.

The algebraical expression of the above rule may be set up as follows:
Let O=zero point of lever arm.
L=long lever in inches.
l=short lever in inches.
x=equal distance from fulcrum f at which the spring balance is applied.
W=weight in pounds.
w=weight indicated by spring balance.
A=area of valve v in square inches ($0.7854\ D^2$).

$$\text{Divisions of 10 pounds each}=\frac{10\,A\,l}{W} \quad \text{.......... 8}$$

$$\left.\begin{array}{l}\text{Distance of zero point behind}\\ \text{fulcrum } f\text{, to balance lever}\\ \text{arm, valve } v \text{ and stem } s.\end{array}\right\}=\frac{w\,x}{W} \quad \text{.......... 9}$$

Practically, the pressure a safety valve lever exerts on the valve v can be ascertained by fixing it in its place, and securing the valve and stem in its proper position, and attaching a spring balance to the lever arm immediately over the centre of the valve v. If the weight W be also attached, in lifting the valve slightly the balance will indicate the total pressure which tends to keep the valve in its sit, which pressure being divided by the number of square inches in the valve area A, will give the pressure p per square inch at which steam will commence to blow off.

Example 9.—A safety valve having a diameter of 2.5 inches, its area A

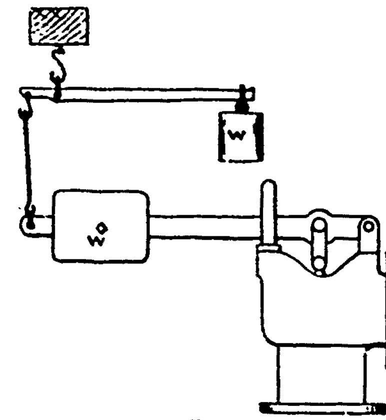

FIG. 12.

will be 4.908 square inches ($0.7854\times2.5\times2.5=4.908$). Now, in raising the lever arm a, valve v, stem s and weight W, attached the spring balance indicates 245 pounds, the pressure at which the valve will lift is the quotient arising from dividing this 245 pounds by the area A of the valve—4.908 square inches.

$$p=\frac{245}{4.908}=50 \text{ pounds pressure per square inch.}$$

The pressure exerted by a safety valve lever can be arrived at with a common steelyard as shown in Fig. 12.

SAFETY VALVES WITH BALANCED LEVERS.

Safety-valve levers are sometimes prolonged beyond the fulcrum f, and provided with an adjustable weight W, which is set to balance the weight of the lever arm a, valve v and stem s, as shown in Fig. 13.

This manner of making safety valves simplifies the calculation very much. The algebraical expression of these values may be set up as follows.

$$W\,L=A\,p\,l \quad \text{.......... 10}$$

Rule.—The weight W, multiplied by the length of the long lever L, equals the area A of the valve v, multiplied by the steam pressure p per square inch, and this product by the length of the short lever l.

$$\text{Weight } W=\frac{A\,p\,l}{L} \quad \text{.......... 11}$$

Rule.—Multiply the area A by the steam pressure p, per square inch, and

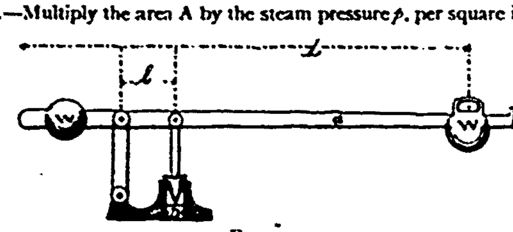

FIG. 13.

this product by the length of the short lever l, and divide this last result by the length of the long lever L; the quotient will be the weight W in pounds.

$$\text{Pressure } p=\frac{W\,L}{A\,l} \quad \text{.......... 12}$$

Rule.—Multiply the weight W by the length of the long lever L, and divide this product by the product of the area A, multiplied by the short lever l; the quotient will be the pressure p per square inch.

$$\text{Lever } L=\frac{A\,p\,l}{W} \quad \text{.......... 13}$$

Rule.—Multiply the area A of the valve v by the pressure p, in pounds per square inch, and this product by the length of the short lever l, and divide this last result by the weight W in pounds; the quotient will be the length of the long lever L.

(To be Continued.)

ACCIDENT PREVENTING DEVICES.*

MANY serious accidents occur from motor engines running away when the governor belt slips or slides off its driving pulley. These may be prevented by the duplication of the valve disks, the invention of the writer, and shown in Fig. 1. The ordinary balance governor valve A is provided with two extra disks B B, which do not interfere with the passage of steam to the cylinder when the governor balls are revolving in the proper working plane; but when they fall, by loss of circular motion, the disks B B are drawn into the ways of the steam and effectually stop its flow, whence the engine comes to a standstill.

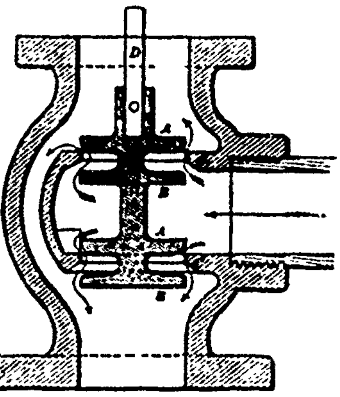

FIG. 1.

Loss of life or limb to an operator very often means the loss of a skilled "hand" to an important industry, as well as the loss to a family of its chief means of support. It may add to the burdens of public institutions, and may lessen the productive power of our mills. Therefore the prevention of accidents, in a humanitarian sense, as well as in a commercial one, should be a matter of deep interest to us, demanding the exercise of ingenuity in the devising of effective means for securing this end.

The subject is a broad one and this paper proposes to merely touch at a few points, and there leave it to the humanely wise to whom a hint is sufficient.

On the well recognized principle that self-preservation is the first law of nature, the duty of establishing and maintaining protective appliances whenever necessary about dangerous machinery becomes apparent, and the effort to do so is worthy of praise, since we find that nature has well considered this necessity, having organized in our being ample means and methods of giving warning of approaching danger, and of guarding us against injury, which are at once effective and beneficient.

Almost every machine has places about it that will pinch the flesh, mash a finger, or crush a bone, and it will perform these cruel acts upon any one who thrusts his members into its open jaws.

With the exercise of ingenuity and care for protecting the machine against injury to itself, the attendant may be protected also, and if proper safeguards be thrown around a machine, such that, with ordinary care and with instructions that may be given, the attendant can perform all the work necessary about and with the machine with perfect safety to himself, thus preserving machine and man, while the employer, who may be held responsible for accidents occurring from exposed machinery, which might have been protected at little cost, will have performed his whole duty.

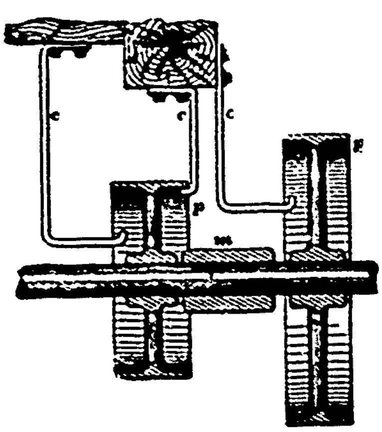

FIG. 2.

A great number of accidents are caused through loss of presence of mind by the eagerness of work people to get through their work expeditiously, under threat of punishment if they do not. The largest contributions to the list of accidents are amputations and maiming of dexter hands, due to this eagerness. If urging must be done, these results of experience call loudly for safeguards and warning mechanism, and the enforcement of stringent rules for safety, which shall be binding alike on employers, on foremen, as well as on the hands themselves.

To prevent accidents happening from belts winding around shafts or couplings of the same, simple and cheap hooks or belt-rests may be devised for and attached in the needed places. They may be located at C, Fig. 2, to prevent a belt from sliding off the pulley, and others at CC, to hold the belt in safe position when off.

In the belt carriers of Mr. Biedermann, which are formed of a bent, flat, iron bow, C, Figs. 3 and 4, generally concentric with the rim of the pulley and around, say four-fifths of its diameter, and carry four to six hook bolts, which project in a circle a few

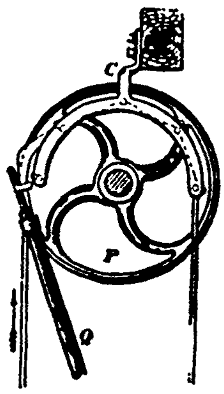

FIG. 3.

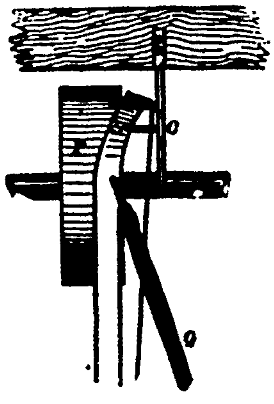

FIG. 4.

inches less than the pulley rim, the first bolt being situated at a point where the belt is taken up, and the last where it is paid out. When the belt is dismounted it is supported by these bolts, retaining a curved position, and is ready to be remounted; it is enough to lift it gently with the long arm Q, surmounted by a curved finger, and bring it in contact with the pulley, when it is immediately carried away on the pulley P without the least exertion.

In the case of a horizontal belt, which is taken up at the top first bolt may be brought as close as possible to the rim of the of the pulley, the appliance is fitted rather higher, so that the pulley; this bolt being removed from a to a, to allow the long arm to guide the belt and to set it on its real position on the pulley (see Fig. 5). F is a light fork of hard wood, which pre-

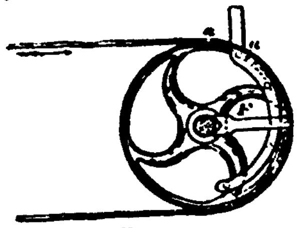

FIG. 5.

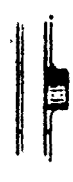

FIG. 6.

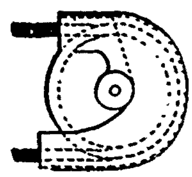

FIG. 7.

vents the appliance from being bent against the shaft when the belt happens to repose upon it. This fork does not touch the shaft when the belt is on the pulley. When the belt is horizontal, and taken up from underneath, the same kind of appliance is used, but in a reverse manner. Oblique belts, whose angle does not exceed 45°, may retain the appliance in its concentric form, but when it exceeds 45° the form adopted for horizontal belts should be used. Workingmen frequently indulge in the bad habit of taking both ends of a belt (which is off the pulley and resting on a running shaft) in one hand, and of pressing them together, in which case a fold is apt to be formed on the slack part, which is liable to be drawn in under the tight part, and the whole be rolled up rapidly on itself on the shaft, with

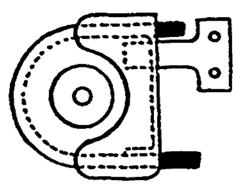

FIG. 8.

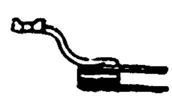

FIG. 9.

risk of accident to anyone who may get caught in its drawing up folds.

Many accidents occur from ropes and chains running off their sheaves; an idea is given in Figs. 6, 7, 8 and 9 of guards applied to such sheaves. These may be modified in a multitude of ways, according to the purpose to be served, whether as a protection to the hand, where the rope must be taken hold of, or as a safety device to the machine itself, for hoists, cranes, and the like, where dislodged ropes would wreck the machine.

To prevent rolling wheels from running over any obstruction

* Extract from a paper presented by John H. Cooper at the Richmond Meeting of Mechanical Engineers.

in their way, a rail guard, shown by Figs. 10, 11 and 12, is provided and attached.

Devices such as these for preventing accidents to machines and their attendants might be reproduced almost indefinitely.

As new "hands" are coming into the mills all the time, who are presumably ignorant of the dangers surrounding them, and of the constant care which is necessary to be exercised over

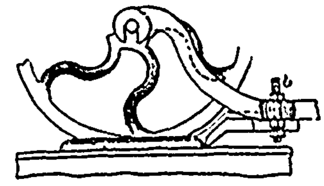

FIG. 10.

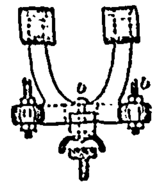

FIG. 11.

persons at all times, and who may meet with accident from such causes, it is desirable to have plainly posted rules, which, if enforced, might enable them to avoid injury.

A rule forbidding the cleaning of shafts and wheels while in motion, with "waste" or rags taken in hand, would save many of these all important members from mutilation or loss.

Stringent, clearly understood rules in regard to starting the motive engine, which should be done only on well determined signals, in cases where repairs are going on in any part of the mill, that no accident may occur to the men at work upon standing machinery; and conversely, plainly visible and easily accessible alarm apparatus should be located at proper places in all the work rooms, which are to be used in cases of accident for signaling the engineer to stop the motive engine at once.

Much has already been done, but much yet remains to substantially protect the attendant against projecting wedges, keys, set screws, nuts, grooves, and the like, of machinery in motion, which are so liable to catch his clothing and scarify his flesh. Many serious accidents have happened from this source, and the exercise of common ingenuity, with uncommon vigilance, seems necessary to reduce their number.

The usual method of protective boxing to belts, ropes, shafts and pulleys, where they pass through floors, should receive attention as their importance demands, and there are peculiar cases of these parts of transmitting machinery that need critical looking after.

The engineer on duty must not be permitted to wear garments with loose, fluttering ends; the same advice may be extended to all attendants, male and female, and to workmen on machine tools or any rapidly going machines.

The subject is an important one, not only in its humanitarian aspects, but in its promotion of increased production, by insuring full confidence to every operative that there is no such thing as harm in any machine, and that accident to man and machine are alike nearest the impossible.

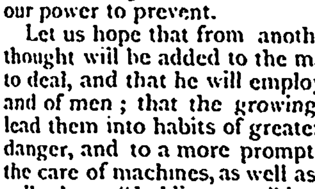

FIG. 12.

Much may be said of the grandeur of our industrial systems and machinery, of the excellence of our contrivances, which will do almost everything except think and talk, yet with their development and use comes a long list of distressing accidents, apparently beyond our power to prevent.

Let us hope that from another presentation of this subject a thought will be added to the many with which the engineer has to deal, and that he will employ it for the safety of the machines and of men; that the growing intelligence of workingmen will lead them into habits of greater watchfulness while in places of danger, and to a more prompt obedience to orders respecting the care of machines, as well as of themselves; and that masters will take a "holding turn" in the consideration and application of protective devices wherever necessary.

QUESTIONS AND ANSWERS.

"A SUBSCRIBER," Brantford, Ont., writes: Will you kindly answer the following questions in the next issue of your journal. 1st. Does the fly wheel increase the working power of an engine? 2nd. Will a drive wheel have the same effect on the engine as an idle fly wheel of equal weight and diameter?

ANS.—(1) A fly wheel, no matter what its weight, does not increase the power of an engine. Its use is to store up the energy imparted to it by the piston at each stroke, and give out that power when the cranks are on the centre and receiving no impulse from the piston. In other words, to produce a uniform motion of the driving power. (2) The drive wheel of equal weight and diameter will have exactly the same effect on the engine as a separate fly wheel.

BOWMAN & ZINKAN, Southampton, Ont., write: Last week we had a very heavy thunder storm, and it seemed to affect our dynamo and circuits to some extent; and in one of our neighboring towns we understand an arc lamp placed in one of the stores was smashed while the dynamo was in operation, and it is supposed it was caused through the effects of the lightning. Would you kindly let us know through the columns of the ELECTRICAL NEWS what effect a heavy thunder storm is likely to have on a dynamo and circuit if in operation, and what precaution can be taken.

ANS.—The effect of an atmospheric discharge known as a static spark or lightning may be disastrous to a dynamo in a number of ways. If the dynamo is not in operation, as a rule no harm is done, the atmospheric spark simply taking the nearest path to complete a circuit or to pass to ground. If in operation, the current of the dynamo is liable to follow the spark and make a short circuit in the dynamo, either perforating the insulating of the field magnets or the armature, or burning out the insulation of the brush holders. All dynamos connected with outside aerial circuits should be protected by some approved form of lightning arrester to conduct the atmospheric discharge to ground, preferably self-acting, constructed to open the ground circuit in case the dynamo current followed the spark to ground. Most makers of dynamos furnish lightning arresters to go with their system.

G. W. writes: I have just had a patch about one foot diameter put on one of my boilers. The patch is 5-16 steel, single rivetted. What pressure can I safely put on it? The boiler is 4 ft. x 12 ft., with 70 three inch tubes in it, thick and double rivetted on the longitudinal seams.

ANS.—The formula reads thus:

$$S.\ W.\ P. = \frac{s \times t}{d \times \frac{1}{2}}$$

S. W. P. means safe working pressure, or the strength multiplied by the thickness, divided by half the diameter in inches, equals what the boiler is safe to work at. Steel 1 inch square has a tensile strength of 60,000 lbs. One-fifth of that is the S. W. P. or strain; or, 60,000 ÷ 5 = 12,000 lbs. 12,000 × 5-16 = 3,750 safe working strain of solid plate. Your patch being single rivetted, the strength has been reduced from .75 to .56 (.75 is the strength of double rivetted seams). 3750 × .56 = 2100 safe working strain of patch. 2100 ÷ 24 inches = 87.5 or 87½ lbs. is the S. W. P. of your boiler.

A. S., Toronto, writes: Can you tell me an easy way of setting Corliss valves and cut off gear to be pretty near correct? My engine is a 13 x 30, running 75 revolutions per minute, with about 80 lbs. pressure as a rule.

ANS.—First roll the engine round in the same direction it runs every day until the rock-arm stands perpendicular (never mind where the crank is now), then take off the back bonnets on the ends of the valves. If you inspect the valves very closely you will see a slight file mark on them; these file marks are the outside edges of the valves. If you look again very closely, you will also see other file marks, one on the outside of each valve seat or steam port; the marks are below the steam valves and above the exhaust valves for the steam ports. Set the steam valves, the two on the top of the cylinder, taking the valve nearest to the cylinder head first, by placing the file mark on the valve ⅛ of an inch past the file mark on the valve seat that is, the mark on the *valve* must be ⅛ of an inch nearer to the cylinder head than the mark on the seat. Now take the valve on the other end of the cylinder and set the file mark on that one ⅛ of an inch past the file mark on the valve seat; that is, the mark on the *valve* must be ⅛ of an inch nearer to the crank end of the engine than the mark on the seat. Next set the exhaust valves, taking the one nearest to the cylinder head first, by placing the file mark on the valve ⅛ inch past the file mark on the seat *in the same direction* as the steam valve over it. Take the other exhaust valve on the opposite end, and set the file mark on the valve ⅛ of an inch past the file mark on the seat in the same direction as the steam valve above it. To set them with accuracy you will have to loosen the arms that work the valves, and shorten or lengthen them according to the way the valves should go. The valves are now set as far as the lap is concerned. You will now get the lead on them. Roll the engine the direction she works until she comes to a dead centre; it does not matter which centre you take first. Loosen the set screws in the eccentric, and put somebody on it with a wrench whilst you go back to watch the valves move. Let the man on the eccentric pull it forward in the same direction that the engine runs until the file mark on the valve gets 3-32 of an inch inside the file mark on the seat (just the opposite way to getting the lap). If the valve is already more than 3-32, push the eccentric back till it is right, and fasten it there, then roll the engine forward again to the next centre, and you will probably find that the file mark on the other valve is already inside the mark on the seat. If it is not quite the same as the other valve, divide the distance you moved the eccentric between the two valves. In giving the lead on the valves when cold, get all you can of the 3-32, as the valves when hot will expand and thus decrease the lead. Having thus set the valves, next get the cut-off. Start up the engine slowly until it begins to cut-off; watch closely the travel of the shoe on the guides, or the position of the crank. If the shoe travels farther on the guides on one stroke than on the other, the cut-off rod on that stroke wants shortening. Suppose it travels a few inches farther when leaving the cylinder head than when coming back again, shorten the long cut-off rod, or shorten the short cut-off rod if it cuts off too far when coming in from the crank end. If these directions are followed closely your engine will be set about as true as you can ever get it without an indicator. By using an indicator you will get the valves set closer than by following all the written instructions in the world.

NOTES ON THE DESIGN OF MULTIPOLAR DYNAMOS.*

5. RELATION OF AIR-GAP TO DIAMETER OF ARMATURE AND NUMBER OF POLES IN DIRECT CURRENT MACHINES.

Having established the proportionality of the volume and diameter, it is easy to find the relation which must exist between the diameter and length of air-gap for any particular angle of embrace in order that sparking may not occur. I need not take up time ringing changes on the several equations, as to obtain the relation now referred to, all that has to be done is to substitute for v in (1) its value in terms of the diameter accordingly, as the winding is of the cylinder or drum type, and find the connection between l and d. Preserving the same safety factor throughout, it will be found that two-pole dynamos with a mean gap induction of 5,000 C. G. S. units per square centimetre, and pole-pieces embracing an angle of 130 deg., must have—the volume being related to the diameter as described—a gap of not less than

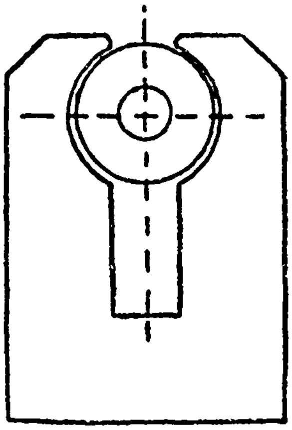

FIG. 3.

.036 d if cylinder-wound, or ·054 d if drum-wound. As will have been observed, the air-gap may diminish as the induction is increased, or as the volume is reduced.

But, as is also seen from the equation, the gap required for any particular volume is proportional to the angle of embrace, and if we substitute for two poles a greater number of correspondingly less angular width, working with an increased diameter and volume without a proportionally increased gap is made possible. This is where the advantage of the four, six, or even eight-pole machine comes in. Keeping to two poles, increasing the diameter requires either a proportional increase in the gap, whether the space is required for the conductors and clearance or not, or an increased induction, or a diminished polar angle, or a combination of these. In either case, the magnetizing force spent in the gap is increased; and, other things remaining the same, obviously it would be of some advantage to adopt a construction which, while producing no greater tendency to sparking, would admit of the air-gap being reduced until its length was just sufficient to accommodate the conductors and allow of the necessary clearence. The workdone by an armature of given external dimensions we have seen to be quite independent of the number of poles, and the choice of this number can only be a question, therefore, of structural and working economy.

6.—DIMENSIONS OF THE ARMATURE

It has been observed that the output of an armature is proportional to d^2 L ; and the induction being the same, the weight of the core for a given number of poles must be proportional to the output, the radial depth increasing directly as the diameter, so that a proportionally increased field may be carried. The number of poles being fixed, the weight of the core for a given output may be taken, therefore, as approximately constant, whatever the ratio of L to d.

As the number of poles isincreased, the induction remaining the same, the radial depth of the core is diminished in proportion, and, within the limits of practice, we make the further assumption that theweight is inversely as the number of poles. The money value of a reduction in the weight of material due to increasing poles can easily be arrived at.

The power wasted in hysteresis is proportional to the weight of iron magnetized, and to number of reversals per second. The weight being inversely, and the reversals directly, as the number of poles, the power wasted is for a given out-put the same; furthermore, as the output is proportional to the speed, we may say that for a given induction to the loss in hysteresis is about proportional to the output only, without reference to speed of rotation, weight of core, or number of poles. If it be more important to reduce the loss by hysteresis than to reduce the weight of material, it can, of course, be done. It is a point for the designer to consider.

So much for the core; let us now consider the copper part. Taking Gramme-wound armatures having an interior opening equal to .66, or two-thirds of the core-diameter, it is found—the output, speed, and temperature being predetermined—that the ratio from L to d may vary through a considerable range without making any great difference in the weight of copper or efficiency. For instance, the most efficient relation being $L=\frac{d}{3}$, it may be varied on the one hand till L $=d$, or on the other till $L=\frac{d}{6}$, without increasing the copper by more than about 10 per cent. Of course the watts wasted in the armature are correspondingly increased, but within the limits of the large variation mentioned the reduction in the electrical efficiency of the machine is under one-half per cent. In two-pole machines L varies from .5 to 1.5 d, the normal relation being about L $=d$. As has been seen, the gap has to be increased in proportion to the diameter, unless a greater number of poles be employed; and the disadvantage of an increased magnetizing force would, in machines with only two poles, counterbalance the slight advantage of getting the armature dimensions nearer the best proportion. When the poles are increased, however, the gap may remain fixed, and if the radial depth of the core be correspondingly diminished, the proportions for least copper and highest efficiency are altered: thus, in a four-pole Gramme we can work from $L=\frac{d}{3}$ up to $L=\frac{d}{12}$ without a greater variation than 10 per cent. in the weight of copper. Observe, this is a question differing altogether from the one which was considered in my former paper. In that case the length and radial depth of the armature over the winding were fixed, the problem then being to find the best relation of copper to iron. Here both radial depth and length of core alter, also the peripheral velocity, though the revolutions per minute remain the same. Why the velocity is allowed to alter will be immediately apparent; I only show at the moment that the dimensions of the armature may have their relations altered considerably without making any considerable difference to the weight of copper or efficiency.

To drum wound armatures precisely the same reasoning applies. Here, speed and temperature being fixed as before, the best proportion for two-pole machines is about L $=3.3\,d$; but

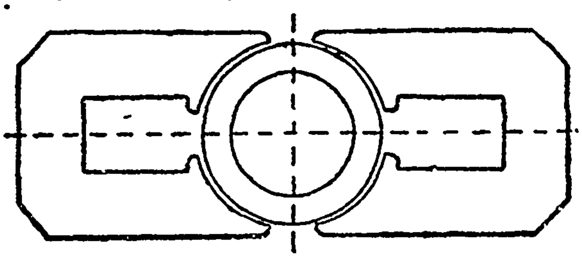

FIG. 4.

because of the distance between the bearings which such a relation would necessitate being inconveniently great, we rarely find L $=2\,d$ exceeded. The latter requires about 5 per cent. more copper than the former; while for the usual proportion, L $=1.5\,d$, 12½ per cent. more is required than for L $=3.3\,d$. The variation which can be made without over-stepping the limits of economy has a smaller range in drum than in cylinder machines, owing to the greater relative importance of the end wires, because of their greater length. If the length of the core is reduced below L $=1.5\,d$, the copper in machines with two-poles increases rapidly; but if the number of poles be increased, the length of the end wires being shortened nearly in proportion, the core length may be reduced to a fraction of the diameter without sacrifice of copper or efficiency. In a four-pole machine, for instance, the same copper is used with L $=.5\,d$, as in a two-pole one with L $=2d$; while for six poles, without increasing the copper, the relation may be as small as L $=.25\,d$. The effect of adding poles when the diameter is relatively great is not so

* Paper read by W. B. Esson before the Institute of Electrical Engineers, London, April 9, 1891.

noticeable in Gramme-wound machines, as the end wires are less important.

All the above facts go to prove that if there is anything to be gained, as regards the production of the field, by increasing the diameter of the armature and the number of poles, there is nothing, considering the armature by itself, to be lost by it. It may in fact, be rather an advantage, because the weight of iron core is reduced. It is true the peripheral velocity is increased; but this does not matter in the least, provided a certain limit is not exceeded. Opinions differ as to what the limit should be, some machines working at 50 feet per second, others at 100, and a few as high as 125. But there is no reason whatever why any properly constructed armature should not run at a periphery speed of 100 feet per second; and provided this velocity is not exceeded, any advantage which may be obtained by a relatively large armature and increased number of poles should be secured.

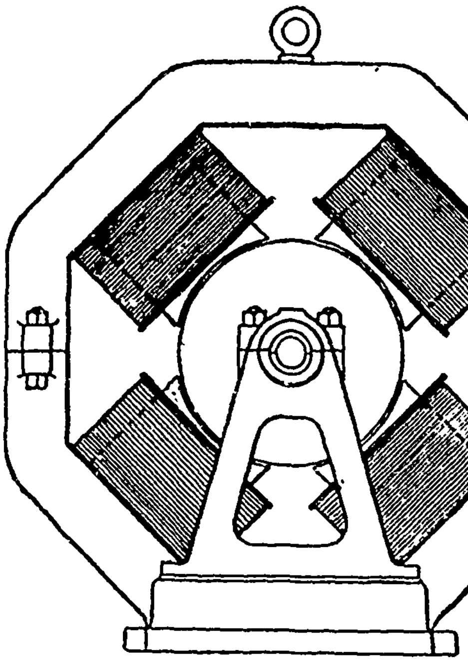

FIG. 5.

7.—DIMENSIONS OF THE FIELD MAGNETS.

It will be apparent, from the foregoing considerations, that the employment of two, or more than two, poles for direct-current machines of moderate dimensions resolves itself mainly into a deliberation regarding the most economical shape to give to the field magnets. As regards the armature, considered by itself we may say that the choice of dimensions is mostly a matter of convenience, seeing that the amount of copper required and efficiency are for a given output practically unaltered by variations in this respect, while the reduction in the weight of the core due to an increased number of poles is to some extent compensated by the extra expense of larger plates and increased weight of the armature supports. Again, the cost of the labor is increased by the larger diameter; but, everything being taken into account, considerations respecting the armature do not influence the design to a very great extent. One thing in favour of increasing the poles, as far as the armature is concerned, must, however, be remembered, and that is the reduction, consequent on a smaller conductor being used, of the losses arising from parasitic currents. We now turn our attention to the magnets.

I have said that for the prevention of sparking it is necessary, that, the induction per square centimetre remaining the same, the air gap increases proportionally to the diameter, whether the space is necessary for conductors and clearance or not, but that the coefficient by which the diameter has to be multiplied to give the length of the gap necessary to prevent sparking, diminishes directly as the pole angle. In comparing the magnet system of a four or six-pole machine with that of a two-pole one, it is necessary to adopt dimensions for the armature in accordance with the considerations already mentioned; hence, if the two-pole armature had a length of core equal to one and a half times its diameter, in a four-pole one the length should be about half the diameter. The diagrams (Figs 3 and 4) show the cross sections of two such machines. The diameter of the four-pole armature is 1.4, and its length .5 times that of the two-pole one, consequently both machines give the same output. The weight of the two horse-shoe magnets in the four-pole machine come to 56 per cent. of the weight of the single horse-shoe magnet, which indicates in this particular case a considerable saving in wrought iron. In taking the copper weight it is necessary to bear in mind that this does not vary simply as the length of the wire if the machines are of the same efficiency, but as the square of the length; so in this particular comparison the copper on the two horse-shoes would be, roughly, 30 per cent. more than on the single horse-shoe, assuming the length of the air-gaps to be the same. Now, if it were possible to reduce the gaps by 12 per cent. or so, the copper weight would be similar in both machines, and we should have credit for a certain amount of iron saved in the construction of the four-pole one, which could be balanced against the increased expenditure for labor. If the gap can be be reduced by more than 12 per cent. always retaining the depth of the winding the same—there is a saving of copper as well as iron, and it is simply the comparison between the value of the copper and other materials used and the cost of the labor in the two cases which determines, least in machines of moderate size, whether two or more poles should be adopted.

In getting out the best relation of L to *d* in the different types of armatures, it is assumed, of course, that, the volume being proportional to the diameter, the depth of the winding remains unaltered, as that is the condition which gives uniform rise in temperature. Accordingly, for a given output, the layer of copper on the armature will be of the same depth whether the machine has two poles and an armature having a length of only half the diameter. But whether it is possible to reduce the gap to an extent which, with an increased number of poles, will lead to a less costly construction, is a question which for machines of moderate dimensions must receive careful consideration in each individual case. The answer depends upon how much larger the gap has to be to prevent sparking in the case of two poles only, than is requisite to accommodate the conductors and allow the necessary clearance. If the difference is considerable, it may pay better to add poles, and reduce the gaps that way, than to do the same thing by diminishing the pole angle or increasing the induction, or both. The question, it appears, is answered in different ways by different people. It is somewhat interesting to note, for instance, that one engineer, distinguished for the past six years as an ardent advocate of multipolar machines, has, after reducing from six poles to four, lately arrived at two, while another has jumped straight away from two to six without a halt at the intermediate number.

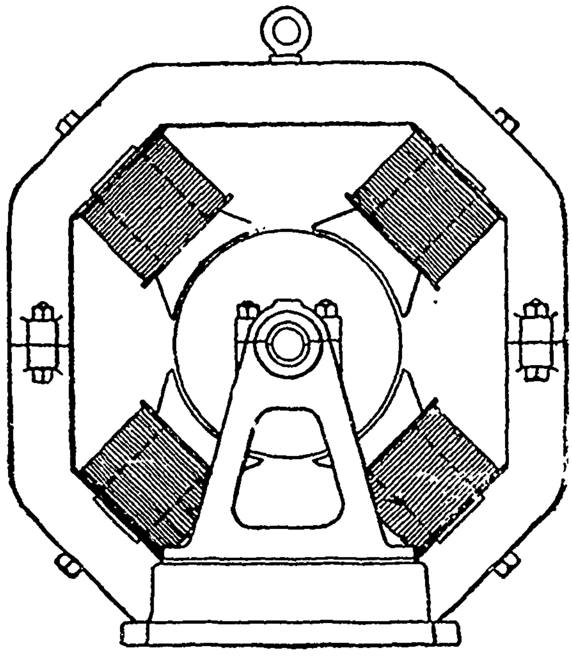

FIG. 6.

But when we come to machines of a certain size there is undoubtedly a gain in employing more than two poles only Consider the case of a two pole armature of 60 centimetres diameter. Assuming the induction in the gap to be 5.000 C. G S. lines per square centimetre, and the pole angle 130 degrees, our calculations show that the length of air-gap would require to be 3.24 centimetres. This is some 40 per cent. in excess of the requirements of conductors and clearance; so, if the gap is reduced until it just allows of the requisite clearance, the induction must be increased from 5,000 to 7,000. Keeping the output of the machine the same, however, we can reduce the diameter of the armature to 54 centimetres, and work with an induction in the gap of 6,500. Observe, the magnetizing force spent in the gap has now been reduced by about 7 per cent., but the total field through the armature has been increased by 15 per cent., and the induction in the armature per square centimetre by more than 25 per cent. If we retain the same section of iron in the fields, it may be assumed then that about the same total magnetizing force is required, whether the machine has an armature 60 centimetres diameter, with a gap induction of 5,000 C. G. S. units, or one 54 centimetres diameter, with a gap induction of 6,500. The latter might turn out to be impossible owing to the greater heating of the armature core; anyway, what I am attempting to show now is, that by pressing up the induction with a view of reducing the gap, little if any, advantage is obtained. But by increasing the number of poles, and reducing the gap in that way, we effect, without increasing the gap induction, a marked economy. As it is unnecessary to go into a mass of figures to prove what each can readily prove for himself from the data already before you, I will just give here the results. If we substitute for the two-pole armature of 60 or 54 centimetres diameter and 90 centimetres long a four-pole one of 84 centimetres diameter and 45 centimetres long, a gap induction of 5,000, we require for the magnetizing coils while working at the same speaking limit, and with the same efficiency, rather under 70 per cent. of the copper on the two-pole field. When to the saving in copper there is added the saving in iron, there will be, after the extra labor is debited against the four-pole machine, a considerable balance in its favour. But to go beyond four poles in this case would be a mistake. Increasing the poles always results in actual increase of copper, unless at the same time the power spent in the gap is reduced, and this latter must be effected without reducing the thickness of the armature winding. The economy shown above is simply due to the fact that, in a two-pole machine of the dimensions specified, the gap necessary for the prevention of sparking must be much larger than the conductors require unless pressed up to a high induction. If with four poles the gap is still larger than necessary, we go to six poles, and so on. But when we arrive at a point where increasing the number admits of no reduction in the gap, we go no farther. It may be mentioned, however, that even in sizes where a four-pole construction showed no actual economy in first cost, it might still be preferable to the two-pole on account of its symmetrical field and the absence of the magnet pull.

(To be Continued.)

Mr. F. J. Barkey, is about to introduce incandescent electric lighting to the citizens of Tilsonburg, Ont., having recently purchased a 300 light dynamo for the purpose.

WAYSIDE NOTES.

(By a Travelling Correspondent.)

The town of Petrolia is very poorly lighted, the townspeople being afraid of adopting more generally the electric light lest it might injure their refined oil trade.

Brooks' Peterborough carbons now seem to be meeting with favor, and the electricians who have tried their last effort say they are equal to the carbons made on the other side.

Oil Springs, where there are about 50 steam plants working the different wells, might digest some of the remarks applying to Petrolia. The engineers of Messrs. Fairbanks keep their several plants in a very clean condition. The working of the engines is conspicuous by the absence of "pounding" so general in many of the plants both here and in Petrolia. If the other owners would only get their "rigs" in the same condition, the improvement would soon pay for itself.

The town of Strathroy has in Mr. S. N. Saylor a townsman who ought to have their support and thanks. Entirely at his own expense he has installed an electric light plant, consisting of a 50 h. p. Wheelock engine and a 4 and 8 ampere dynamo 1,000 and 2,000 lights. The town and stores have 30 arc and 5 incandescent lights. Still, the fact is to be regretted that the storekeepers and hotels do not more generally adopt the light. Possibly if the town had'nt it, they would lament the want of it.

The Forest City (London, Ont.) Electric Light Co., which is owned by Messrs. Hunt Bros., are seeking incorporation. The plant consists of two engines, 210 h. p., and a water power of 125 h. p., operating four 40 light, one 20 light and one 10 light Royal dynamos. This Company supply eighty-five arc lights 2,000 c.p., and ten incandescent to the city, and fifty-five arc lights to private users. The plant is under the able supervision of Mr. Robt. A. Lyons, with Mr. Richard Shapland as engineer and assistant.

Petrolia being the seat of the Canadian oil supply for lubricating purposes, may have an interest to our engineer readers. I visited a great number of the oil wells, also the whole of the refineries. The crude oil is forced by a Jerker pump from the rock. Some of our readers may not have seen the "Jerker": I will explain. The "Jerker" is a wheel laid horizontally, and is worked from the engine by two shafts at each point of its diameter. The shafts work alternately, consequently giving the Jerker motion. From this wheel are attached lines to the pumps at the wells, and by this method as many as 150 wells are pumped by the one engine. At the refineries the crude is distilled and the different oils given off and afterwards manufactured into the cylinder and machinery oils. Some of the boilers here are in such a state that perhaps many of the engineers in our cities would be afraid to run them, the water being very hard and the boilers consequently scaly. I saw three of them opened, and the scale was of a thickness varying from ¼ to ½ inch. Some of of the boilers are run night and day, two men to each "rig," working twelve hours per day each. Don't you think these hours are too many? I do! But there is no help for it—"If you don't like it, you can leave it; lots of men (not engineers) to take your job." The well owners seem to have been very much afraid of the original Engineers' Bill becoming law lest they would have to employ competent men. One of them even went so far as to send a petition against the Bill to the member representing his constituency. It was signed by himself, and the words "and others" added thereafter. Quite a numerously (?) signed petition, eh! There are plenty of good engineers in Petrolia, and lots of material to make more. The men have never had a chance of improving themselves, and have (owing to their long hours), never had inclination or encouragement to do so. There are over 400 steam plants in this oil territory, and out of this number I got only about 50 subscribers. This number is the smallest average by 75 per cent. in the whole of the cities and towns canvassed. This ought not to be. It is to be hoped for the credit of the engineers themselves in the Petrolia oil territory that they will not be behind the engineers in other towns and cities in recognizing in your journal a means of improving their intellectual and financial standing.

I thank those engineers of Petrolia who so kindly let me their assistance in getting subscribers; also for their information respecting their different plants.

SPARKS.

The first transformer was constructed by Faraday in 1831.

Arrangements will shortly be made to light the town of Athens, Ont., with electricty.

The wires are being laid which are to operate the electric railway at St. John, N. B.

All the necessary arrangements have been made for the transmission of power to operate the electric apparatus at the Montreal exhibition.

Messrs. Guillaume & Felton, manufacturers of electrical wires and cables, Germany, have cabled for space at the coming Montreal electrical exhibition.

Mr. Allen, of Gloucester street, Ottawa, has invented an electric light hanger, for the patent of which he is said to have had some good offers.

Mr. D. Thomson has succeeded Mr. Clarke as manager of the Hamilton Electric Light and Power Co. It is rumored that Mr. Clarke will represent the Brush Co.'s interests in Canada.

Negotiations are said to be in progress for the purchase and reorganization by a syndicate of the Sarnia Gas Co., the intention being to increase the stock to $100,000, and introduce the electric light.

The Fort Wayne Electric Co., through its Canadian agents, Mr. W. J. Morrison, Toronto, and Mr. A. J. Corriveau, Montreal, has signified its intention of presenting to McGill University, Montreal, a valuable electric light plant.

The important fact is announced that the London Edison Light, Heat and Power Co. has been organized to introduce an underground electric light (incandescent) and power system at London, Ont. Toronto capitalists are said to own one-third of the capital stock, which amounts to $75,000.

The recently completed telephone line between London and Paris has two complete circuits, so that if an accident happens to one the other is available. A strand of copper weighing 160 pounds per mile composes each conductor, while each strand is covered with alternate layers of a composition and gutta percha. The four conductors are twisted spirally around each other, and the strand thus formed is covered with twisted hemp, while outside of this is a covering of sixteen galvanized iron wires also spirally wound.

A recent issue of the *Zeitschrift fur Elektrotechnik* gives some interesting particulars on the duration of currents employed in telegraphic transmission. According to this journal the currents from a Morse instrument have a mean duration of 0.125 seconds; with the Hughes from 0.04 to 0.05 seconds; with the Meyer multiple 0.007 seconds; with the Delaney multiple 0.002 seconds, and with the Wheatstone automatic 0.0018 seconds, at the rate of 600 words per minute, giving 33,600 currents per minute.

The Hamilton Electric Light and Power Co. has been organized with a capital stock of $200,000, the whole of which has been subscribed. The officers elect are: R. Æ. Kennedy, president, Robert Thomson, vice-president, J. V. Teetzel, Q.C., secretary-treasurer; D. R. Dewey, H. S. Stephens, of Hamilton, H. M. Pellatt and W. H. Howland, Toronto, and D. Graham, Montreal, directors. It is understood to be the intention of the new company to add largely to the plant and buildings for the purpose of supplying incandescent lighting and power.