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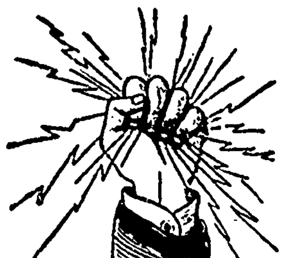

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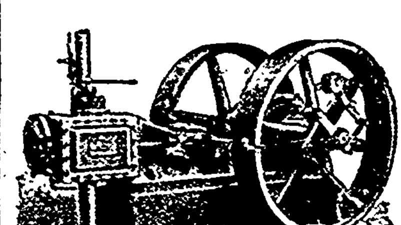

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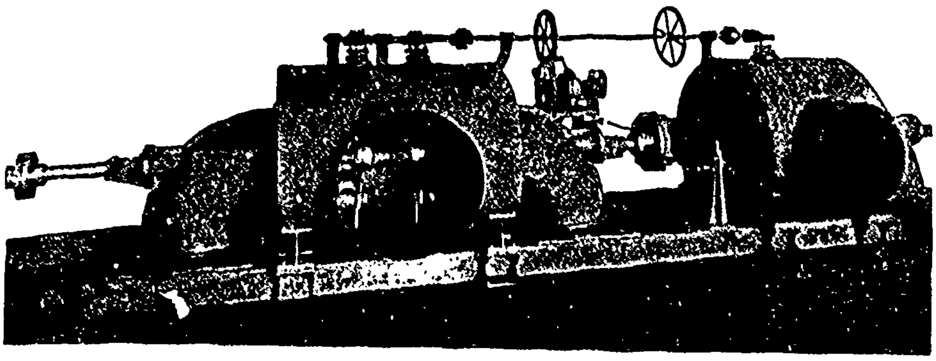

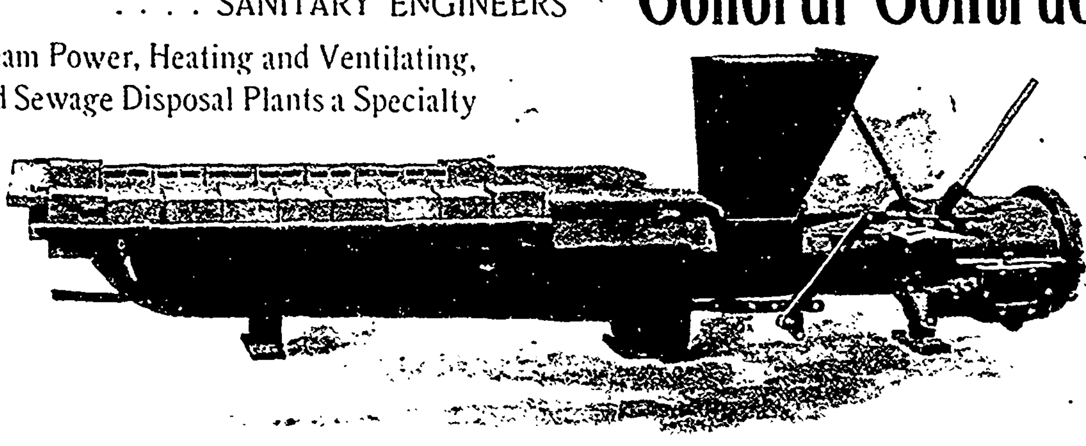

CANADIAN
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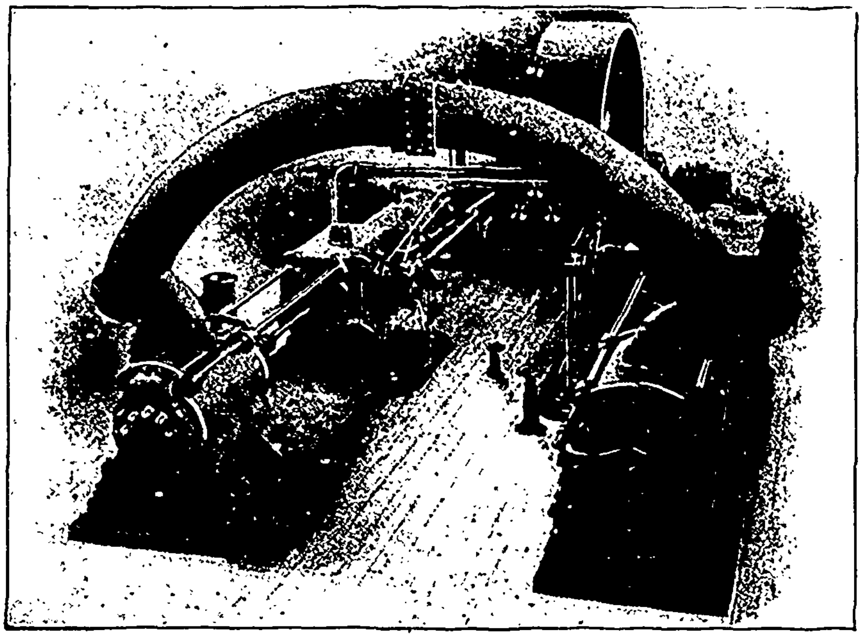
AIR COMPRESSOR AT LE ROI MINE.

WHAT is claimed to be the largest air compressor ever put in operation in Canada was recently installed at the Le Roi mine, Rossland, B. C., by the Rand Drill Company, of 100 Broadway, New York. It was built at their Canadian shops at Sherbrooke, Que., and is shown in the accompanying illustration.

The steam end is of the Corliss cross-compound condensing type, with high-pressure cylinder 22 inches in diameter by 48-inch stroke, taking steam through a pipe 6 inches in diameter. The low-pressure cylinder on the opposite side of the machine is 40 inches in diameter by 48-inch stroke. Both cylinders are fitted with the Corliss liberating valves, with vacuum dash pot, controlled by a sensitive governor operating on the releasing gear, the speed being automatically governed from six or eight revolutions to the maximum number of revolutions per minute, depending upon the air pressure. The main shaft is 14 inches in diameter by 13 feet long, weighing about 5,500 pounds. The shaft is fitted with cranks pressed on under immense pressure. The connecting rod forgings and piston rod forgings are well and carefully finished. The air end of the machine is placed tandem with the steam cylinders, and is also of the compound type, the high-pressure air cylinder being 22 inches in diameter by 48-inch stroke. The valve motion supplying these cylinders is Rand's most economical type, being in the form of mechanical valves. The use of these valves insures the filling of the low-pressure cylinder with air at atmospheric pressure, which fact largely affects the efficiency of the machine, for were the cylinder either not completely filled, or were the air hot and expanded, in just such a ratio would, it is said, the efficiency be decreased. The inlet valves of the low-pressure or intake air cylinder are surrounded by a hood, which is connected to a flue for the introduction of the cold air from out of doors. Between the high and low-pressure cylinders is an intercooler of the latest type, through which the air passes over a system of water circulating pipes and is cooled in the process. This giant compressor engine will be used for running all the pumps and hoists at the mine, in addition to operating 40 drills.



AIR COMPRESSOR AT LE ROI MINE, ROSSLAND, B. C.

NOVEL METHOD OF UTILIZING WATER POWER.

PARTICULARS of a new method of utilizing the power of falling waters are given as follows in the *Mining and Scientific Press*:

The essential principal involved is the compression of air by the force of the falling water, and the compressed air used to drive motors at the falls or be transmitted to a distance for the same purpose. From a tank or a stand-pipe, in which the water stands at the same level as above the dam, the water is permitted to pour down a pipe, around whose base are a number of holes, admitting air from tubes running up to the surface of the water. The air is sucked in and compressed by the water, and the two are automatically separated by gravitation, the air passing into a storage or supply chamber. The incredible statement is made that from 70 to 80 per cent. of the latent energy in the falling water can be rendered available in this manner. This is no more than a turbine yields, but the latter cannot transmit its energy to a distance within the interpolation of dynamos and motors in which some loss of power occurs. It is said a plant operating on this principle is to be installed at the Dominion Cotton Mills in Magog, near Montreal.

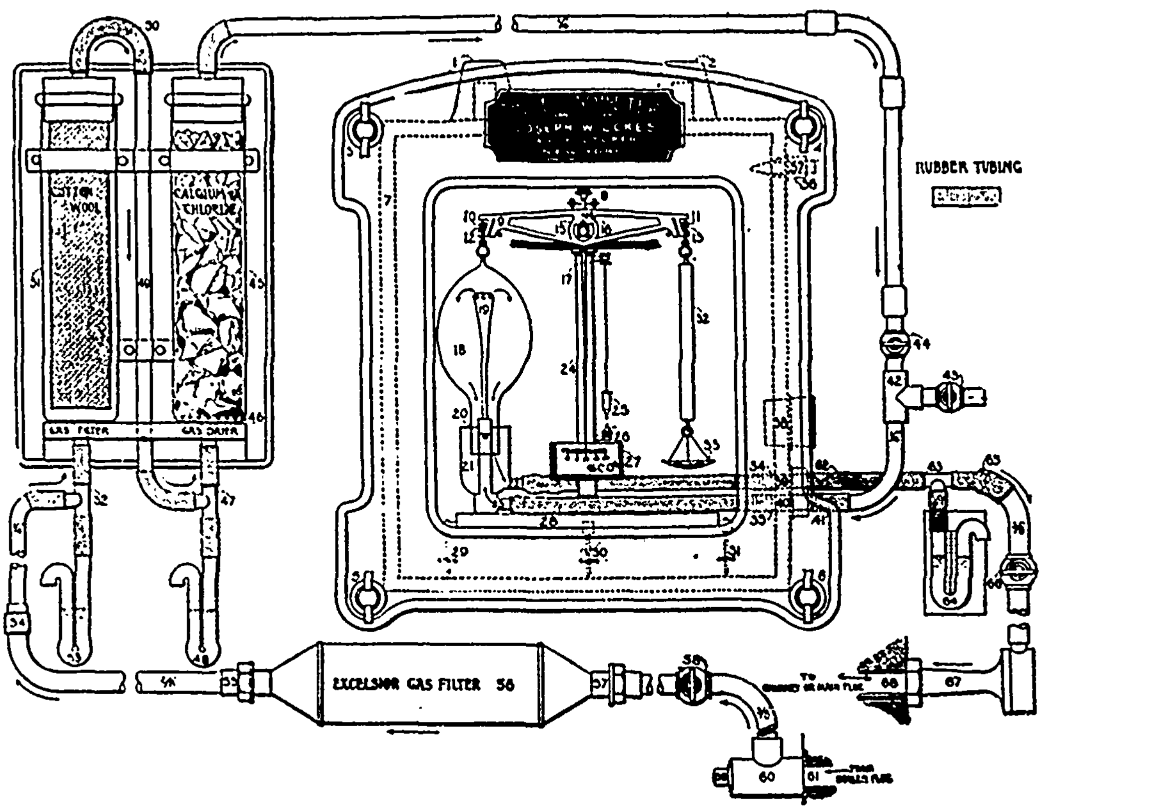
Kinetic energy is the energy of motion. Thus, if a fly-wheel is in rapid motion it possesses kinetic energy.

Potential energy is the possibility of doing work possessed by a body. If a heavy stone is placed at the top of a high building it possesses potential energy. If dislodged it will do work in falling. There is in the stone the possibility of work.

THE "ECONOMETER."

THE following is a description of an instrument, called the Econometer, designed to indicate permanently the conditions of combustion in boiler and other furnaces. This apparatus is designed to prevent a loss of heat resulting from an excessive amount of superfluous air passed through the furnace, and which has to be heated to the high temperature of the exit gases. If just as much air could be conveyed to the fuel as it needs for perfect combustion, the combustion gases would contain about 21 per cent. of CO_2, as atmospheric air contains 21 per cent of oxygen. Carbonic acid being formed by the combustion of the carbon with the oxygen of the air, it follows that the percentage of CO_2 in the gases is larger the less superfluous air is admitted to the furnace. As this instrument shows continuously the amount of CO_2 in the gases, it is a permanent indicator to the stoker to regulate its firing according to its indications.

The Econometer consists of a finely adjusted balance



enclosed in an iron case. The gases are taken from the boiler, led through two filters to retain the dust, and then passed through the drier to retain the moisture. The gases, perfectly clean and dry, enter the weighing globe 18. The CO_2 being 50 per cent. heavier than atmospheric air, fills, mixed with the gases, the inside of this globe. The heavier its contents, the more it is lowered and the more the balance indicates. The gases enter by inlet pipe 23 and 19, and are drawn out by 22 to the chimney. The chimney suction increased by an aspirator 67 draws the gases continuously from the boiler. The Econometer is fitted in plain view of the stoker on a cool wall or board in order to cool the gases down to atmospheric temperature. The inside of the Econometer case is constantly supplied with sufficient air through air inlet 56 to be able to weigh CO_2 in air. This is also drawn off to the chimney through cup 21.

In practice proper firing means from 12 to 15 per cent. of carbonic acid in the combustion gases. A surplus of air would be shown by lower readings. Thus the stoker is enabled by proper attention and regulation of the damper to get the best possible results from the fuel.

The Econometer is being introduced in the United States and Canada by Mr. Joseph Wilckes, of 100-108 Fulton street, New York. It is largely in use in most European countries, and several have also been installed in the United States.

Messrs H. McLaren & Co., 706 Craig street, Montreal, are the agents for Quebec and the eastern part of *Ontario*. They will be glad to give any further information.

DEVELOPING AN IMMENSE WATER POWER.

THE West Kootenay Power and Light Company, Limited, which was recently organized for the purpose of developing the magnificent water power available at the Falls of the Kootenay, in British Columbia, ten miles from Nelson, has just closed a contract for the hydraulic and electrical machinery, to develop 2,000 horse power immediately, the ultimate scope of the undertaking being the utilization of the full power of the river at this point, estimated at from 8,000 to 10,000 horse power. At the head of the company is Sir Charles Ross, Bart., who is largely interested in mining properties, and with him are associated Messrs. C. R. Hosmer, Frank Paul, and other influential and well known capitalists.

The services of Mr. Robert Jamieson, formerly engineer in charge of the Lilooet, Fraser River & Caribou Gold Fields Co., Limited, have been secured to supervise the entire undertaking, and his wide experience in mining engineering work of all kinds will insure the most efficient working out of all the detail appliances necessary to apply the electric power in the most satisfactory manner for mining work.

Some interesting details as to the electrical features of the scheme have been made known. The apparatus, which will be furnished by the Canadian General Electric Company, Limited, will be of the three-phase alternating type, similar to that now being installed in the large power plant of the Lachine Rapids Hydraulic & Land Company at Montreal. The initial generating plant will consist of two machines, of the revolving field and stationary armiture type, having a capacity of 1,000 horse power each, from which the current will pass through step-up transformers, raising it to 20,000 volts, the highest pressure as yet used on any electric transmission line. At this high pressure the energy will be carried to a sub-station at Rossland, a distance of thirty miles, where it will be reduced to a pressure of 2,000 volts, for transmission to the motors used in connection with the different mining operations.

The electric power will be furnished for operating tramways, hoists, pumps, ventilators, stamp mills, compressors, drills, etc., and will be sold at a price which, in comparison with the present high cost of power generated from coal, means a greatly reduced expenditure in this direction by the different mining companies. The machinery is now in the course of construction and the plant is to be in full operation early in the fall.

TORONTO TECHNICAL SCHOOL EXAMINATIONS.

As announced in our May issue, we publish below the answers to the Technical School examination questions in Electrical Engineering and Steam and the Steam Engine, as furnished by Mr. James Milne, lecturer in these subjects. The working of the problems in Electrical Engineering is shown in full, but in the case of Steam only the answers are given. Should any of our readers desire to see the working out of some of the most difficult of the questions we will be pleased to publish the same for our August issue. For the questions in Steam and the Steam Engine readers are referred to the May number of the ELECTRICAL NEWS.

ELECTRICAL ENGINEERING.

1. What data do you require for determining the amount of current as measured by the Tangent or Sine galvanometer? Work out the formula, and make the necessary sketches to illustrate your answer.

ANSWER.—Let X Y represent the plane of the coil and needle lying in the magnetic meridian and suppose A O B to represent the direction the needle has assumed under the influence of the

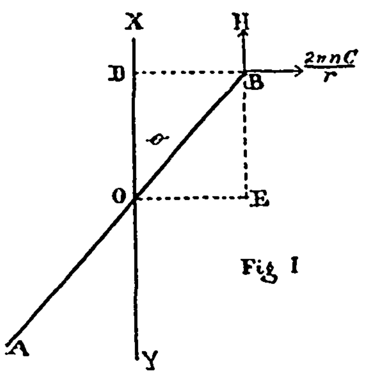


Fig I

current. This direction will be the resultant of two forces, viz., the force $2\pi nC/r$ exerted by the current and the horizontal component of the earth's magnetism H. Since the needle is at rest the moments of these forces must be equal, i. e. $\frac{2\pi nC}{r} \cdot DO = H \cdot OE$ or $\frac{2\pi nC}{r} = H.\frac{OE}{DO}$. But $OE = DB$ and $\frac{OE}{DO} = \frac{EB}{DO} = \tan\phi$, $\therefore$ $2\pi nC = H \tan\phi$.

The quantity $\frac{2\pi n}{r}$ is dependent on the form and size of the instrument. From the equation we see that the data necessary for determining the amount of current in the tangent galvanometer are the values of n, r, H and the tan ϕ. Where n = No. of turns of wire, r = radius of the coil, and H = the horizontal component. In Toronto its value is about .1664 C. G. S. units.

In the sme galvanometer, instead of measuring the deflection as in the above, the coil is turned round so as to follow the needle, which, of course, deflects it still further; the coil is therefore turned still further round until finally the plane of the coil and the direction of the needles are once more parallel. In Fig. 2 let X Y = the original position of the coil and needle in the magnetic meridian and A B

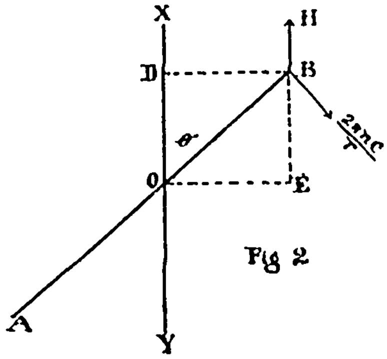


Fig 2

the final position of coil and needle. Then $2\pi nC/r$ will be the force tending to send needle at right angles to the plane of the coil, but H will tend to bring the needle back to the magnetic meridian. If the needle is at rest the moments about the centre O must be equal, i. e:

$$\frac{2\pi nC}{r} \times BO = H.EO$$

$$\text{or } \frac{2\pi nC}{r} = H.\frac{EO}{BO}, \text{ but } \frac{EO}{BO} = \frac{DB}{BO} = \sin\phi \text{ of deflection}$$

$$\therefore \frac{2\pi nC}{r} = H\sin\phi$$

$$\text{or C in C G S units} = \frac{H\sin.\phi\, r}{2\pi n}$$

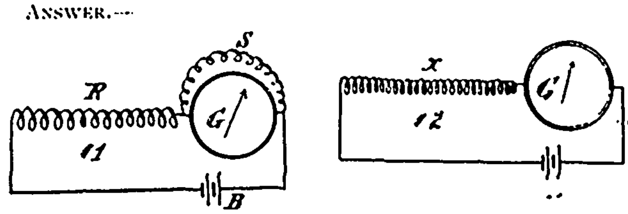
The data necessary being exactly the same as in the tangent galvanometer, the only exception being that the sin is substituted for the tan.

2. How would you determine the value of an unknown resistance if you were supplied with a Weston voltmeter, the resistance of which is known, together with a known E. M. F. and whatever wires, etc., are necessary for making the necessary connections? If voltmeter has 20,000 ohms R, and the E. M. F. is 600 volts, when the unknown R is put in circuit voltmeter shows 375 volts, what is the value of the resistance?

ANSWER.—Unknown resistance 6666.6 ohms.

3. With a shunted galvanometer, when a resistance of .1 megohm was in circuit, a deflection of 10° was observed when battery key was pressed. With same battery and shunt removed, there was a deflection of 5° when a certain resistance was in the circuit. Determine the value of the resistance. The resistance of the galvanometer was 7,920 ohms, and the shunt was 1/99th. Omit in the calculation the battery resistance. Make a sketch of the arrangement, and show clearly how you arrive at your results.

ANSWER.—



R = .1 meg.	X = Unknown resistance.
G = 7,920 ohms.	G = 7,920 ohms.
S = 1/99th.	d_2 = 5°.
d_1 = 10°.	B = Battery R.
B = Resistance of battery.	

$$C = \frac{E}{R} = \frac{E}{R + \frac{G.S}{G+S} + B} = k\,d_1\,\frac{G+S}{S}$$

$$E = \left(R + \frac{G.S}{G+S} + B\right)k\,d_1\,\frac{G+S}{S} \quad (1)$$

Without shunt we get

$$C = \frac{E}{X+G+B} = k\,d_2$$

$$E = (X+G+B)k\,d_2 \quad (2)$$

as E is the same in equation (1) as in (2) then

$$(X + G + B)\,k\,d_2 = \left(R + \frac{G\,S}{G+S} + B\right) k\,d_1 \frac{S}{G+S}$$

omitting B which is very small and cancelling k

$$(X + G)\,d_2 = \left(R + \frac{G\,S}{G+S}\right) d_1 \frac{G+S}{S}$$

$$\therefore X = \frac{\left\{\left(R + \frac{G\,S}{G+S}\right) d_1 \frac{G+S}{S}\right\}}{d_2} - G$$

and substituting the values as given above we get

X = 20,007,920 ohms or 20 megs. fully.

4. The electro-chemical equivalent of zinc is .00034. What do you understand by this? What would be the deposit in an Edison chemical meter, the German silver shunt having a resistance of .01 ohms, and the resistance of the voltameter and the coil in series with it being 48.96 ohms, when a current of 100 amperes has been passing for 4 hours. Make a diagram showing the arrangement.

ANSWER.—One coulomb deposits .00034 grams, electro chemical equivalent.

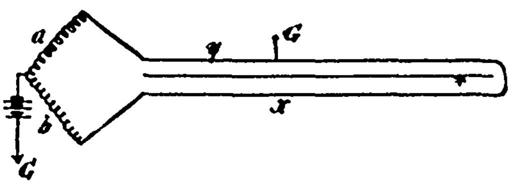
∴ Amount of current × electro chem. equivalent × time in seconds = deposit.

In the question the resistances are as .01 : 48.96

∴ 1/4897 of 400 × .00034 × 3600 = 100 milligrams will be the deposit.

5. In an Edison underground 3-wire system, the distance from power-house to feeder junction box is 6,000 feet. The copper resistance is .017 ohms per 1,000 feet. The two outside wires are looped together at one end (the junction box), and at the other the ends of the loop are attached to the terminals of the galvanometer. A 150-ohm resistance coil of 200 turns is also connected to the terminals of the galvanometer, and at a distance of 20 turns from one end one pole of a 4-cell battery is attached, the other pole being attached to ground. In this position there is no deflection of the needle. Find the location of the fault and give distance in feet from the power house.

ANSWER.—



a = 15 ohms.
b = 135 ohms.
l = total length x + y = .2040 ohms.
x = l-y.
a x = b y.
a (l-y) = b y.
a l = y (a + b).

$$y = \frac{a\,l}{a+b} = .0204 \text{ ohms or } 1200 \text{ feet.}$$

6. What is the size of the conductor in the above question?

ANSWER.—Knowing that the resistance of one mil foot is 10.4 ohms we can easily find the diameter in mils.

or $d = \sqrt{611{,}750}$ = 782 mils or .782" diameter.

7. What data would you require to determine the permeability of an electro-magnet core which lifts a weight P pounds? Investigate a formula. What do you understand by permeability?

ANSWER.—The lifting power of a magnet in dynes is $\frac{B^2 A}{8\pi}$ where B = induction per square centimeter and A = area in square centimeters, from which we can easily get

$$B'' = \sqrt{\frac{\text{pull in lbs.}}{\text{area in square inches}}} \times 8494 \qquad (1)$$

when B" is = lines of force per square inch.

The law of the magnetic circuit being

$$\text{magnetic flux } N = \frac{\text{Magneto motive force}}{\text{Reluctance}} = \frac{\frac{4\pi \text{ Amp. turns}}{10}}{\frac{l}{A\,u}}$$

$$= \frac{4\pi \text{Amp. turns} \times A\,u}{10\,l} \text{ for centimeter measurement,}$$

from which we get

$$N = \frac{3.2 \text{ amp. turns} \times A\,u}{l''} \text{ for inch measurement}$$

when A" = area in square inches.
l" = length in inches.
u = permeability.

$$\frac{N}{A''} = B'' = \frac{3.2 \text{ amp. turns} \times u}{l''}$$

$$\text{But in (1) } B = \sqrt{\frac{\text{lbs.}}{\text{area}}} \times 8494$$

$$\therefore \frac{3.2 \text{ amp turns} \times u}{l''} = \sqrt{\frac{\text{lbs.}}{\text{area}}} \times 8494$$

from which we get

$$u = \sqrt{\frac{\text{lbs.}}{\text{area}}} \times \frac{l''}{\text{amp. turns}} \times 2660$$

From this equation we see that the data necessary for determining the permeability, u, the specific conductivity for magnetic lines or multiplying power of the material which lifts a weight of P lbs. will be the following: The area in square inches of the magnet, the length of the core in inches and the number of ampere turns.

8. A current of 20 amperes, flowing through a resistance of 10 ohms, heats 20 lbs. of water from 60° to 70° Fah. How long was current flowing, supposing there was no loss by radiation?

ANSWER.— Let J = Joules mechanical equivalent.
H = No. of heat units.
1 lb. deg. Fah. = 1047.3 watts.
J H = Work done = C^2 R t
where t = time in seconds

$$\therefore t = \frac{J\,H}{C^2\,R} = \frac{1047.3 \times 20\,(70 - 60)}{20 + 20 + 10}$$

= 52.4 seconds nearly.

9. What is the efficiency of an electric motor when running up to its maximum? Prove it.

ANSWER.—*When motor is standing still the current that will flow through the winding will be* $\frac{E}{R}$ where E = E M F of supply and when running

$$C = \frac{E - \text{counter E M F}}{R}$$

Useful work $= C \times$ *counter E M F = counter E M F* $\left(\frac{E - \text{C. E M F}}{R}\right)$

Work spent in heating the conductors = C^2 R

Total watts = E C = C^2 R + C × counter E M F

$$= C^2 R + \text{counter E M F}\left(\frac{E - \text{C. E M F}}{R}\right)$$

but C^2 R = C × counter E M F

∴ E.C = 2 C^2 R

E = C 2 R

$$C = \frac{E}{2\,R}$$

which shows that one-half the total power supplied is spent in heating the wires, and that the mechanical work given out by the motor is a maximum when the current is reduced to one-half the strength it would be if the motor was standing, and its efficiency is therefore ½ or 50%.

10. Describe the Aron or Thomson wattmeter.

ANSWER.—The Thomson wattmeter is sufficiently well known that no description here is necessary. The following may prove interesting to some regarding the Aron meter.

Let E = E M F at service
C = current
T = term of one oscillation of correct clock
T_1 = " " " " retarded "
g = gravity
C. E H = magnetic force
l = length of pendulum

$$T = \pi\sqrt{\frac{l}{g}} \qquad T_1 = \pi\sqrt{\frac{l}{g - \text{C. E. H}}}$$

$$\frac{T}{T_1} = \frac{\pi\sqrt{\frac{l}{g}}}{\pi\sqrt{\frac{l}{g - \text{C E. H.}}}} = \frac{\sqrt{\frac{l}{g}}}{\sqrt{\frac{l}{g - \text{C. E. H.}}}}$$

$$\left(\frac{T}{T_1}\right)^2 = \frac{\frac{l}{g}}{\frac{l}{g - \text{C. E. H.}}} = \frac{l\,(g - \text{C. E. H.})}{l\,g}$$

$$\left(\frac{T}{T_1}\right)^2 = 1 - \frac{\text{C. E. H.}}{g} \text{ or } \frac{T}{T_1} = \sqrt{1 - \frac{\text{C. E. H.}}{g}}$$

So that this meter will record accurately the magnetic force, which should be very small compared with gravity, therefore $\frac{\text{C. E. H.}}{g}$ must also be very small compared with unity.

$$\therefore \left(1 - \frac{\text{C. E. H.}}{g}\right)^{\frac{1}{2}} = \left(1 - \frac{\text{C. E. H.}}{2\,g}\right) \text{very nearly}$$

or $\frac{T}{T_1}$ $\frac{1 - C. E. H.}{2g}$ nearly, or the rate of loss in the second clock equals $\frac{C. E. H.}{2g}$ which is directly proportional to C × E.

11. Make a diagram showing the connections in the Brush or Thomson-Houston arc dynamos. Make sufficient sketches to fully illustrate the changes that take place in one revolution. Also describe some form of regulator for arc machines.

ANS. A detailed description of this is not necessary here.

12. What does the torque of a motor depend on? Prove your statement.

ANS. E.×C. = 2πnT×1.356.

When T torque in pound feet and the multiple 1.356 is to bring pound feet to watts.

But E is proportioned to the speed if the flux N is constant, or

$$E = \frac{n\ N c\ n}{10^8} \quad \text{where}$$

n revs. per second. Nc = No. of conductors.

If we substitute this value of E in the first equation we get

$$\frac{n\ Nc\ n}{10^8} \cdot C = 2\pi nT \times 1.356$$

$$\frac{Nc\ n}{10^8} \cdot C = 2\pi T \times 1.356$$

$$T = \frac{Nc.\ n.\ C}{10^8 \times 8.52}$$

Showing that the torque depends only on the current and the flux N.

13. What do you understand by the "Constant" of a galvanometer? What data do you require in determining it? Give an example and show clearly what is meant by it.

ANS. Take the first sketch in question No. 3, together with the same data.

$$R = \text{Total Resistance} = (.1\ \text{meg} + \frac{G\ S}{G + S} + B)$$

$$= (100.000 + \frac{G\ S}{G + S} + B)$$

Galvanometer Constant = Degrees deflection × power of shunt × R

$$= d^1 \left(\frac{G + S}{S}\right) R$$

$$= 10 \times (100,000 + \frac{7920 + 80}{8000} + B)$$

and if we assume B = 200

then Constant = 100,279,200 ohms

or Constant in megohms = 100.28.

This number represents the deflection that would be produced on the scale if there was 1 megohm in circuit, if no shunt was used; or if 1 ohm was in circuit there would be 100,280,000 degress deflection.

Example showing the working after constant has been determined:

Cable 200 miles, deflection 100°, constant 100.28; what is the R?

$$R \text{ of cable} = \frac{100.28}{d} = 1.0028 \text{ megs.}$$

Resistance per mile = 200.56 megs.

STEAM AND THE STEAM ENGINE.

ELEMENTARY.

ANS. 1. 138960 ft. pds. 746215.2 ft. pds.

2. Cut-off 1/5th stroke. 16.1 lbs. M.E.P.

4. 17 in. diam.

5. 70 lbs. nearly.

6. 1571 sq. feet: 524 h.p.

8. (1) 1 : (2) 1.8 : (3) 2.7

10. $h = \frac{G}{4\pi^2 n^2} = 6$ in.

11. 68% lost.

ADVANCED.

12. 1⅛ in. open to steam; full port opening to exhaust, the edge of the valve travelling 3/16 in. past the edge of the post.

13. This was intended to be solved graphically, by Dr. Zeuners method. The accompanying diagram shows how the positions are arrived at, from which it is seen that the piston is ⅓ in. from end of stroke when admission takes place; 18.4 in. at cut-off, 23 *in. when exhaust opens and 4⅓ in. at compression.*

[The last part of the question has been omitted, as it will not affect the working. Further explanation to those desiring same will be freely given.—J. M.]

14. 23.45 I.H.P; 18.57 B.H.P; .79 efficiency.

15. 25.9 lbs. water.

17. 14.3 lbs. difference in M.E.P.

18. Would take too much space to answer.

19. Pitch 2.186 in., 3.328 in. and 4.47 in. for single, double and triple rivetted joints respectively. Diam. of rivets 1·044 in. Strength of joints as compared with orginal plate = .52 for single, .69 for double, and .77 for triple rivetted joint.

20. 417 lbs. per sq. in. for longitudinal and 1534 lbs. per sq. in. for transverse seams.

21. As no tables are allowed at the examination the total heat *must be calculated from the date given. Boiler efficiency .8;* h.p. = 123; 10.6 lbs. equivalent evaporation; from and at 212 in.; 13.5% gain.

22. M.E.P. on high press. cyl. 60 lbs.; M.E.P. on intermed. cyl. 24 and 10 lbs. M.E.P. on the low press.; diam. of h.p. piston 29⅛ in., intermediate 46½ in., low press. 72 in.

23. 178 h.p.

QUESTIONS AND ANSWERS.

"SUBSCRIBER," Hull, Que., writes: What is the indicated horse power of an 8" × 10" non-condensing engine running 125 revolutions per minute, steam pressure at 100 lbs., cutting off at half stroke? Also what is the average pressure throughout the stroke?

ANSWER.—We will assume that the above pressure signifies gauge pressure, which gives us 115 lbs. absolute, *and that the back pressure is 5 lbs. above atmosphere* or 20 lbs. absolute, then the

Mean effective pressure =

$$\text{Initial pressure} \left(\frac{1 + \text{hyp. log of } R}{R}\right) - \text{back pressure}$$

where R = Ratio of expansion =

$$\frac{\text{Length of stroke + clearance}}{\text{Distance travelled by piston before steam is cut off + clearance}}$$

or leaving clearance out of the calculation, we get

$$R = \frac{\text{Length of stroke}}{\text{Distance travelled by piston before steam is cut off}} = \frac{10''}{5''} = 2$$

$$\therefore \text{M.E.P.} = 115\left(\frac{1 + .693}{2}\right) - 20 = 77.3475 \text{ lbs.}$$

To find the horse power

$$\text{H.P.} = \frac{2\ R.\ A.\ P.\ S.}{33000}$$

Where R = Revs. per minute.

A = Area of piston in square inches.

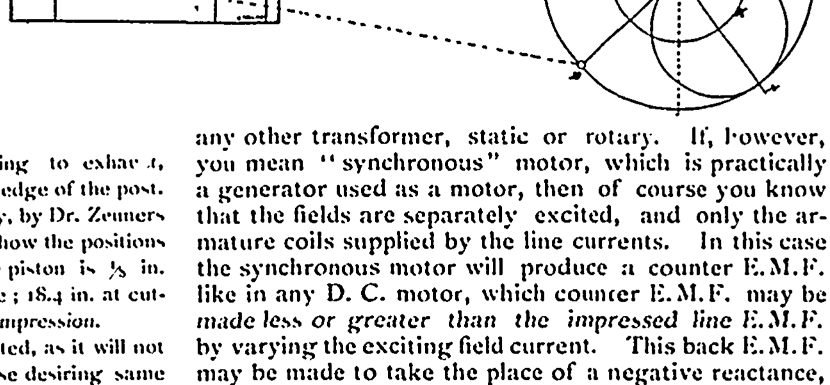
P = M.E.P. as found above.

S = Length of stroke in feet = 10/12.

$$\text{or } \frac{2 \times 125 \times 50.26 \times 77.3475 \times 10}{33.000 \times 12} = 24.54 \text{ h.p.}$$

"J. A. G.," Peterboro', Ont., asks: On a three-phase synchronous motor, carrying a standing load to increase the field current, thereby increasing the E. M. F., the current remaining the same, how is the increased energy accounted for, the speed remaining the same?

ANSWER.—If you really mean an "asynchronous" motor, then your question is impossible of answer. "Asynchronous" is the same practically as "induction" motor, which permits of no more field variation than



any other transformer, static or rotary. If, however, you mean "synchronous" motor, which is practically a generator used as a motor, then of course you know that the fields are separately excited, and only the armature coils supplied by the line currents. In this case the synchronous motor will produce a counter E.M.F. like in any D. C. motor, which counter E.M.F. may be *made less or greater than the impressed line* E.M.F. by varying the exciting field current. This back E.M.F. may be made to take the place of a negative reactance, having a condenser effect, and tending to produce a leading current, which, however, being wattless, takes no energy. This is probably what you want to know.

APPLIED MECHANICS.

THE following is a copy of the examination paper in Applied Mechanics submitted to the students of the Toronto Technical School at the closing of the 1896-97 term. Solutions of the questions, as worked out by the examiner, Mr. James Milne, will be given in our August issue:

ELEMENTARY.

1. State the principle of a lever, and prove it when P and W act on opposite sides of the fulcrum. A weight of 5 lbs. is hung at one end of a uniform bar, which is balanced over a knife edge at a point of 14 in. from the end at which the weight hangs. If the bar weighs 30 lbs., find its length.

2. Define kinetic energy. How does it differ from potential energy? If a velocity of 300 feet per second is impressed upon a weight of 10 lbs., what is the measure of the energy now imparted to the weight?

3. What is the modulus of elasticity of a substance? A round bar of iron, 12 feet long and 1½ square inches in area, is held at one end, and pulled by a force till it stretches ⅛ in. Find the force, the modulus of elasticity being 30,000,000.

4. What do you understand by the efficiency of a machine, and how is it measured? In a single purchase crab, the pinion has 12 teeth and the wheel 78 teeth, the diameter of the barrel being 7 inches and the length of the lever handle 14 inches. It is found that the application of a force of 15 lbs. at the end of the handle suffices to raise a weight of 280 lbs. Find the efficiency of the machine.

5. A cubical box or tank with a closed lid, the length of a side being 4 feet, rests with its base horizontal, and an open vertical pipe enters one of its sides by an elbow. The tank is full of water, and the pipe contains water to a height of 1 foot above the top of the tank. What are the pressures on the top, bottom and sides of the tank?

6. A beam of timber rectangular in transverse section is 2 in. broad, 3 in. deep, and 4 ft. long, and rests upon supports at its ends. The breaking load at its centre is 2,000 lbs. What would be the breaking weight if the beam had been 4 in. deep, 2 in. broad, and 4 ft. between supports, but loaded at a distance of 1 ft. from the end?

7. What is the "pitch" of a tooth of a spur wheel? Two parallel shafts whose axes are to be as nearly as possible 2 ft. 6 in. apart, are to be connected by a pair of spur wheels, so that while the driver runs at 100 revolutions per minute, the follower is required to run at 25 revolutions per minute. Calculate the diameters of the wheels, and, supposing the pitch to be 1¼ inches, ascertain the number of teeth in each wheel.

8. A uniform beam weighing 1 ton rests on supports at its ends 20 feet apart. Weights, 5, 10 and 15 cwts., rest on the beam at a distance of 6 feet apart, and the weight of 5 cwts. being 4 feet from one end, and the 15 cwts. 4 feet from the other. Find the reactions at the supports and the centre of gravity.

9. A safety valve 3 in. diameter, steam pressure 80 lbs. per square inch; from fulcrum to centre of valve 3 in.; lever 30 in. long, and weighs 10 lbs.; centre of gravity of lever 10 in. from fulcrum; weight of valve 3 lbs. What weight is required at end of lever so that steam will just blow off?

10. Friction being neglected, find the force which will support 1 ton on an incline of 1 foot vertical and 10 feet along the incline. If the incline were 1 foot vertical and 280 feet along the incline, find the force in lbs. that would support 1 ton.

11. The accumulated work of one pound of gunpowder is 70 foot tons. Find the amount necessary to project a shot of 5 cwt. at a velocity of 1,000 feet per second. If the charge were 100 lbs., find the weight projected at the above velocity.

12. A locomotive together with train weighs 100 tons and runs at the speed of 30 miles per hour on a level rail. Find the horse-power if friction is 8 lbs. per ton. If the rails had an incline of 1 per cent., what additional horse power would be required?

ADVANCED.

13. In a Weston pulley block the sheaves are 9 inches and 8½ in. diameter. What weight could be lifted (neglecting friction) by a pull of 50 lbs. on the chain? Since in this block the weight remains suspended when there is no pull on the chain, what do you infer as to the limit of efficiency? How would you determine the actual efficiency of the apparatus?

14. The foot of a uniform derrick pole weighing 2 cwts., rests on the ground, and the pole carries a weight of 1½ tons suspended from its upper extremity. The length of the pole is 20 feet, and is kept in position by a guy rope fastened to the ground 10 feet to the rear of the foot of the pole, and 25 feet in length. Find by calculation the tension on the guy rope, and by construction the thrust on the jib.

15. A wooden beam, 12 in. deep, 6 in. wide, and 12 ft. long, is imbedded in a wall at one end. What weight will the beam carry at the outer end, if the B. W. of a beam 1 ft. long, 1 in. x 1 in., supported at the ends and loaded at the centre, is 500 lbs.? What is the shearing force.

16. The table of a drilling machine is raised and lowered by a single threaded worm and worm-wheel in combination with a rack and pinion. A pressure of 10 lbs. is applied at the end of the handle, which is 12 in. long. The worm-wheel has 24 teeth, and the rack pinion has a pitch circle of 2 in radius. What weight placed on the table would be balanced under these conditions, supposing that 50 per cent. of the work applied is lost in friction, and that the table together with the moving attachments weigh 5 cwts?

17. Draw an isosceles triangle with the verticle angle at 120°, trisect the base, join the points of trisection with the vertex, and draw perpendiculars from the points of trisection upon the sides nearest to them. Regard the figure as a roof truss with a load of 2,000 lbs. upon each rafter, whereof 1,000 lbs. is carried at the middle joint. Find, by calculation or otherwise, the stresses on the various members.

18. Determine the horse power which may be transmitted by a leather belt 36 in. wide and ⅜ in. thick, running at 80 ft. per second, the tension on the slack side being 4/10ths that on the tight side, and the maximum strength allowed 300 lbs. per square inch.

19. Taking the weight of a cubic foot of leather to be 60 lbs., determine the effects due to centrifugal force in the above question.

20. A shaft, having a stepped cone, revolves at a constant speed of 200 revolutions a minute, and is connected by means of a crossed belt. The diameter of the largest step is 14 inches. The driven shaft is required to run at speeds of 250, 175, 130 and 90 revolutions per minute. Determine the diameter of all remaining steps of the two cones, and also the length of the belt required if the distance between the centres of the shafts is 10 feet.

21. A uniform platform A B, weighing 3 cwts., is supported at B by a hinge. At A a 20 foot chain is attached and hung from a hook vertically above B. A weight of 10 cwts. is placed 2 feet from A. If the distance A B is 12 feet, find the tension of the chain and the direction and magnitude of the reaction at the hinge.

22. In an epicyclic train consisting of three wheels, the first is a dead one, consisting of 60 teeth, and the second has 30 teeth, and the third 40 teeth. Ascertain the number of revolutions the second and third wheels make for each revolution of the arm, together with the direction of same relative to the arm. If the wheel of 60 teeth makes 2 revolutions in the same time as the arm makes 1 revolution, but in the opposite direction, determine the number of revolutions of the second and third wheels.

23. A locomotive weighs 45 tons, and one-third of this weight rests on the driving-wheels. The co-efficient of friction being ·175 between the wheels and the rail, what load will the engine draw on the level if co-efficient of traction be 8 lbs. per ton? What load would the engine draw up a 4 per cent. grade at the same speed?

24. The diameter of a fly wheel is 20 feet; depth of rim 12 in.; width of rim 18 in. Running at 80 revolutions per minute. Find the centrifugal force and bursting stress. A cubic foot of cast-iron weighs 450 lbs. Take the radius of gyration as being 9.5 feet.

25. What would be the maximum number of revolutions the above wheel could make per minute, taking the tensile strength of good cast-iron as being 20,000 lbs. per square inch.

PATENTS FOR ELECTRICAL DEVICES.

PATENTS have been granted in Canada for the following devices: Canadian General Electric Co., Toronto, electric circuit controller; W. W. Jacques, Newton, Mass., electric power converter; M. Rangey and Peter Plante, Schenectady, N. Y., trolley switch; W. J. Greene, Cedar Rapids, Iowa, automatic cut-out for electrical transmission; Canadian General Electric Co., Toronto, regulator for alternating current circuits; Bell Telephone Co., telephone circuit; G. L. Campbell, Kinsman, Ont., dynamo electric machine; H. A. Parrish, Jackson, Mich., electric trolley signals for railways; Wm. Rosco Smith, Manchester, N. H., electric heating apparatus; Canadian General Electric Co., Toronto, electric brake; Fred. Green, Hull, Que., electrical thermostat; J. J. Teetzel, St. Thomas, Ont., air brake; G. J. Scott and W. S. Janney, Pennsylvania, system of electric distribution; J. A. Gowans, J. S. Fuller and M. Macfarlane, Stratford, Ont., electric annunciator.

CORRECTION.

IN connection with the new schedule of rates adopted by the Inland Revenue department for the inspection of electric light meters, and published in our last issue, a light was said to mean a 16 candle-power lamp consuming electrical energy at the rate of 15 watts. This should have been 55 watts.

WANTS IT OFTENER.

MR. Chas. E. Taylor, Sault St. Marie, Ont., in renewing his subscription to THE NEWS, writes: "Switch it in again; I hope soon to see it twice a month."

Is your piston rod in line, or are you a good customer for the packing man?

Are your belts running with as little tension as possible, and thus avoiding excessive friction?

It is a good idea to be as economical as possible in the use of oil, but it does not pay to attempt to run an engine with an insufficient quantity of cylinder oil, for not only will the cylinder be ruined, but you will use extra oil enough to much more than pay for all the cylinder oil needed.

Paper telegraph poles are the latest development in the art of making paper useful. These poles are made of paper pulp, in which borax, tallow, etc., are mixed in small quantities. The paper poles are said to be lighter and stronger than those of wood, and to be unaffected by sun, rain, dampness, or any of the other causes which shorten the life of a wooden pile.

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The "Canadian Electrical News" has been appointed the official paper of the Canadian Electrical Association.

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Regulating Devices for Light and Power.

STEAM engines with automatic variable cut-offs were the outcome of a demand for constant speed of rotation to be maintained on shafting driving fluctuating loads; and high speed, automatic cut-off engines were more especially the outcome of a demand for a prime mover to actuate high speed electrical machinery without countershafting. But, because automatic cut-off engines were specially designed for use in electric service is no reason why they should invariably be used, without reference to the conditions of a particular case, unless those conditions are such as to call for them. As automatic cut-offs were designed to meet the conditions imposed by a rapidly fluctuating load, where the load is practically constant, as in most smaller central *stations on their arc systems, it will be evident that* a less expensive and complicated type of engine will suffice. Even in incandescent systems a little observation will show the engineer at which time he may expect an increase in his load, and he can then meet it by opening the throttle a little wider. In a lighting plant, although, of course, the load varies greatly between the early part of the night and the morning hours, still the variations are not of the character of fluctuations in a railway plant, but a gradual increase and decrease which may be accurately predicted and thus allowed for. On an arc load this variation almost entirely disappears, and therefore the necessity for any close regulation. What is really required is a good constant steam pressure, and then any good engine may be expected to give satisfactory service without expensive centrifugal speed regulating devices. Similarly with compounding devices for generators, it is often claimed that a generator so wound as to over-compound to some definite percentage at full load is so much a better machine for central station use as to justify a great increase of price over that of a machine the pressure of which can be regulated only by hand. Where the load rapidly fluctuates up and down, as in a railway plant, this is quite reasonable, but in a purely lighting plant, where it increases and decreases slowly and regularly, the necessary voltage adjustments can be made by hand quite satisfactorily. It is a great mistake to base the details of any new plant merely on conventional practice, without regard to special conditions which are presented by everyone, the more carefully any case is studied the greater is likely to be the economy in first cost, and in subsequent operation.

Efficiency of Transformers. FOLLOWING our remarks in last month's issue on the subject of transformer losses, we have seen results of a test recently made by an unbiased engineer on a number of transformers of Canadian make. They were all new, and of sizes varying from 1,250 watts to 5,000 watts. Between the best and the worst of the former size there was found a difference of 34.1 watts of core losses; between the best and worst of the 2,500 watt size there was a difference of 60 watts core loss; between the best and worst of the 5,000 watts a difference of 16 watts core loss and 37 watts copper loss. These losses mean coal wasted, and placed on a reasonable basis show that the transformers with the lower losses in the above cases were worth more as investments than the others by $25, $35, and $15.25, for the respective sizes as above; that is to say, that the better transformers at $50, $70, and $30.50 were just as good investments as the worst at $25, $35, and $15.25, and at any lower prices were distinctly better investments. This is not a supposition case, but an actual occurrence, and should be an object lesson of great value to the large class of purchasers who are guided by price more than intrinsic value. We quote from a report of Prof. Jackson, who after giving a table of such core losses, etc., as may reasonably be allowed on transformers of various wattages, says, "The guarantees outlined may be easily met by any transformer manufacturer who builds safe and economical transformers, and they are now met by a number of makers. Transformers that do not meet the insulation and heating guarantees are unsafe to use upon commercial electric lighting or motor circuits, while those that do not meet the iron loss, regulation, and exciting current guarantees waste the company's money."

Merits of Transmission Systems. AT a time when the long distance transmission of power by electrical means is being very eagerly discussed, and attention drawn towards the various polyphasal systems as rendering such possible, one is rather apt to be carried away by the enthusiasm of the moment and believe that only by the use of high voltage polyphase currents is it practicable to transmit over great distances with a reasonable expenditure. It is, however, not only interesting but also instructive to observe that in Europe, where, as is admitted by unprejudiced American engineers, engineering is more thorough and probably better than on this side of the Atlantic, a considerable number of quite important transmission enterprises have adopted the continuous current series system; placing as many separate machines in series as may be necessary to generate a high difference of potential, which in some cases has been so great as 14,000 volts, used with success. The series system is, of course, adopted throughout, necessarily, all motors being also in series on the same circuit as the generators. Constant current series machines are now being built both in Europe and America of very much larger size than was considered possible a few years ago; five years ago a 50-light arc machine was thought to be the limit -generating a difference of pressure of about 2,500 volts, now the most prominent makers guarantee machines with a capacity of 125 lights, or 6,250 volts. There are no doubt certain grave objections to the series method of transmission, but, as compared with the high voltage, polyphase alternating method, it presents some evident advantages. The disadvantages may be said to be the necessity of generating at once the full pressure used on the system, instead of being able to generate a low one on the machines, which can be raised by means of step-up transformers; the impossibility of using the simple induction motor; and the necessarily more complex current and speed regulating devices for both generators and motors. Against these may be placed the higher resultant efficiency of the total series plant as compared with the resultant efficiency of an alternative system, by the elimination of all losses due to capacity and inductance in the transmission wires, and those due to hysteresis, and lag in both transformers and induction motors. The difficulty of constructing continuous current machines for such high voltage is overcome by first-class methods and materials, and the entire practicability of this method of transmission seems to be vouched for by the fact that for four years it has been in continuous operation under a pressure of 3,500 volts per machine, and that quantities of power up to 1,200 h.p. are daily being transmitted over distances up to 20 miles, in Switzerland, Hungary and France, and are being utilized freely and satisfactorily in units so small as 2 h.p. We shall hope to see this system introduced shortly into Canada, where we have so many large water powers.

CONGRATULATIONS TO MR. FREDERIC NICHOLLS.

THE recent meeting of the National Electric Light Association of the United States held at Niagara Falls, N. Y., is unanimously considered by the electrical press, voicing the sentiments of those in attendance, to have been the most successful from all points of view in the history of the Association. The credit for this successful meeting, as well as for the excellent work done by the Association during the current year, is evidently regarded as being in a very large measure due to the work of the President, Mr. Frederic Nicholls, general manager of the Canadian General Electric Co., as the following resolution clearly shows:

At the twentieth Convention of The National Electric Light Association, held at Niagara Falls, New York, June 10th, 1897, the following preambles and resolutions were unanimously adopted:—

Whereas The National Electric Light Association has during the past year, and at this its twentieth convention, achieved an equalled success, it is hereby resolved That the congratulations of the Association be and are hereby extended to Mr. Frederic Nicholls, its President for this year, upon the brilliant results attending his administration of its affairs.

Resolved, that Mr. Nicholls be complimented especially upon the exemplary zeal and untiring energy with which he sought and found opportunities for the Association's greater usefulness and made the organization more than ever a power for good in the light and power industry, and among the local central stations of the country.

Resolved, that in particular Mr. Nicholls be felicitated upon the cheering triumph, during his memorable term of office, of the Association's long continued endeavor to secure an authoritative national code of wiring rules, upon the movement to standardize incandescent lamps, and upon the remarkable stability in funds and membership with which his period of presidential service closed.

Resolved, that these expressions of heartiest esteem and goodwill towards one for so many years an offical of the Association be appropriately engrossed and presented by the Secretary to Mr Nicholls.

(Signed) SAMUEL INSULL, President.
(Signed) GEO. F. PORTER, Secretary.

TEST OF THE TORONTO RAILWAY COMPANY'S BOILERS.

THE accompanying table gives the results of a set of tests made by Mr. George H. Barrus, of Boston, on the boilers of the Toronto Railway Company's plant, to determine the economy due to the use of Green's economiser.

This plant embraces six boilers of the Scotch marine type, the dimensions of which are 10 ft. in diameter and 14 ft. in length. Each boiler is fitted with Fox corrugated furnaces, provided with grates 6 ft. long and 3 ft. wide, and each has 80 4-in. tubes running from end to end. The area of grate surface in each boiler is 86 sq. ft., about 40 per cent. of which is air-space, and the area of heating surface is approximately 1,500 sq. ft. The whole plant of six boilers has 216 sq. ft. of grate surface, and approximately 9,000 sq. ft. of heating surface. Steam is used by a number of engines which furnish power for generating the electric current used by the railway. The plant is in operation, under its normal conditions of work, for a period of about 18½ hours each day. During this period the average amount of current generated is some 2,400 amperes, at a pressure of 550 volts. For the remaining period of 5½ hours the load ranges from 80 to 280 amperes, one of the smaller engines being in use during the greater portion of this time. During the night period two of the boilers are kept in continuous operation, but the fires in the remaining boilers are banked. At the time of the tests all the six boilers were in operation, and the fuel used was a mixture of Pittsburg slack coal and pea and dust anthracite from the mine, in the proportions of two loads of the former to one of the latter. The fires were cleaned three times during the full run of 24 hours. At times of the heaviest load the plant required the assistance of some of the old boilers of the station.

The fuel used on the tests was that commonly burned, that is, a mixture of Pittsburg slack and pea and dust from the mine. The proportions were approximately 66.5 per cent. of the former and 33.5 per cent. of the latter on both tests. The calorific value of a sample of this coal, as determined in Barrus's calorimeter, is 13,121 B.T.U. per pound of coal, and 14,875 B.T.U. per pound of combustible, the ash being 11.8 per cent. The spreading system of firing was employed, the thickness of the bed of coal being about 6 in., and the fires were frequently broken up and levelled off. During the progress of the tests the regulating damper in the main flue was constantly wide open, and at both tests the boilers were run at practically full capacity.

On the test with the economiser in use 6,510 lbs. of coal were used by the old boilers, and on the test without the economiser 20,390 lbs. The water supplied to the old boilers was not measured. These boilers have no connection with the economiser, and consequently their work had no direct bearing upon the main test. The coal which they consumed, here noted, is in addition to that recorded in the table. The saving due to the economiser is shown to represent 18.3 per cent. of the coal required when the economiser was not in use, and amounted for a day's run to 21,385 lbs., or 10.7 tons of coal. The efficiency of the plant or the percentage which the heat utilized bears to the calorific value of the coal when the economiser was in use, was 70.6 per cent. It may be added here that the maximum temperature of the water leaving the economiser during the trial was 253 degrees.

DATA AND RESULTS OF EVAPORATIVE TESTS ON TORONTO RAILWAY COMPANY'S BOILERS.

Conditions as to Running of Economiser.	Economiser running.	Economiser not running.
1. Duration.....hrs.	19.66	19.72
2. Weight of dry coal consumed.. lb.	95,310	104,372
3. Weight of ashes and clinkers....lb.	14,417	15,932
4. Percentage of ashes and clinkers.....per cent.	15.1	15.3
5. Weight of water evaporated....lb.	788,717	702,610
HOURLY QUANTITIES.		
6. Coal consumed per hour........lb.	4,847.9	5,292.7
7. Coal per hour per square foot of grate.....lb.	22.4	24.5
8. Water evaporated per hour.....lb.	40,113	35,634
9. Equivalent evaporation per hour, feed 100 deg., press. 70lb.....lb	40,435	36,602
10. Horse-power developed, A.S.M.E. basis of 30 lb.....h.p.	1,347.8	1,202
AVERAGES OF OBSERVATIONS, &c.		
11. Average boiler pressure........lb.	120.3	119.3
12. Average temperature of feedwater at point of entering economiser.....deg.	101	96.4
13. Average temperature of feedwater at point of leaving economiser.....deg.	237	...
14. Average temperature of flue gases at point of entering economiser.....deg.	620	607
15. Average temperature of flue gases at point of leaving economiser.....deg.	293	...
16. Average draught suction in main flue near boilers.....in.	0.83	1.16
17. Weather and outside temperature	Clear Moderate	Cloudy Moderate
RESULTS.		
18. Water evaporated per lb of coal..lb	8.275	6.731
19. Equivalent evaporation per lb. of coal from and at 212deg......lb.	9.586	7.828
20. Equivalent evaporation per lb. of combustible from and at 212deg.lb	11.291	9.243
21. Weight of dry coal required to evaporate 788,717lb. of water supplied at 101deg. (for 24 hours' run) based on above results......lb.	95,310	116,695
22. Saving of coal due to economiser for 24 hours' run.....lb.	21,385	...
23. Percentage of saving due to economiser.....	18.3	..

NOTE.—The temperature of the flue gasess here given does not include the night period from 12 midnight to 6 a.m.

PERSONAL.

Mr. Ormond Higman, Chief of the Electrical Inspection Department of the Dominion Government, returned last month from British Columbia and the Northwest Territories, having been absent several weeks. While there Mr. Higman established offices and appointed inspectors for these districts to inspect electric light meters, in accordance with the Electric Light Inspection Act. He advises us that the gas inspectors have been commissioned to act in this capacity, as was the case in the eastern provinces.

Mr. W. McLea Walbank, managing director of the Lachine Rapids Hydraulic & Land Co., has been elected a member of the executive committee of the National Electric Light Association of the United States. As the holding of the executive offices in the association is an honor very much sought after, the election of Mr. Walbank to the executive committee following the occupancy of the president's chair by Mr. Frederic Nicholls, is an appreciative recognition of the importance of Canadian electrical interests on the part of our American confreres.

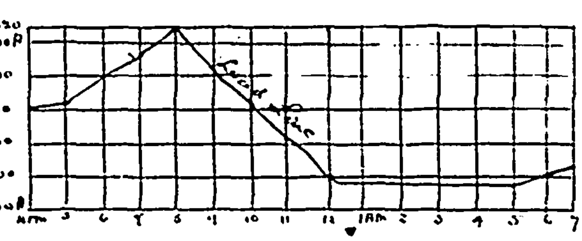
WHY SOME LIGHTING PLANTS DO NOT PAY.

By George White-Fraser.

At the last convention of the Canadian Electrical Association there were some very valuable papers presented; valuable not only in themselves, but because of the discussions they gave rise to. Probably that one presenting features of most practical interest to central station owners was Mr. Armstrong's, on the above subject, and while necessarily limited to mere general indications as to the reasons for failure to produce dividends, many points were made of great importance. Mr. Armstrong, in his last paragraph, states that he had intended to take up the subject of "engineering and operation, taking up, first, the question of selection of apparatus, etc., and considering how far deviations from such an ideal installation were responsible for failure to get best results in a given case." Although this part of the subject seems thus to be considered of secondary importance, I think it really deserves to be placed before the other. I think it will be at once admitted that for each case there is a certain amount and combination of *machinery, lines, etc., that will best and most efficiently perform* the work, and that any deviation from this best combination will introduce an inefficiency into the working. It follows, therefore, that a poor, or even moderately injudicious design or combination, will *impose on the plant an inefficiency that can never be overcome*, even by the most intelligent, educated management. Once a plant is bought and installed, there's an end of it; it has got to be operated just as it is; and any little expense arising from the very many possible errors in design of a plant containing both the steam and electrical machinery will be a yearly loss just as long as the plant continues to operate in that state. You can engage an inexperienced engineer, and he can learn; you cannot teach machinery. In my experience, electric light and power plants in the Dominion are not designed at all, or if they have been, it has been by someone who has had machinery to sell, and who has therefore been more interested in selling a plant than in considering how it is going to operate afterwards. The consequence is that, I might really say, the majority (certainly the large majority of those I have seen), while having everything of good quality, good boilers, engines and shafting, good dynamos and lines, etc., regarded as electric lighting plants, and not merely as exhibitions of different kinds of machinery, are very ill adapted for economical operation under their local conditions.

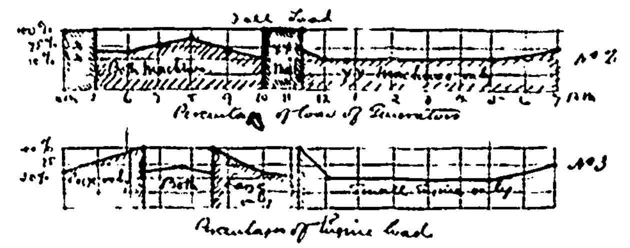
Mr. Kammerer, in his very useful paper on "Day Loads," says truly that now-a-days a central station man when purchasing machinery asks, not "What is the price?" but "What is the efficiency?" This question itself indicates a very long stride forward; but let me suggest to central station men that *the most vital question* is not "How am I to get the most efficient machine?" but "How am I to get the most efficient plant?" The dynamo is not the only machine in a plant, and efficiency is a matter involving every apparatus from the boiler to the lamp. The highest "plant efficiency" is attained only when every piece of apparatus works harmoniously with the rest in attaining the object for which the plant was constructed, at the lowest possible cost. Regarded in this light, a dynamo may have a very high specific efficiency and yet be an important factor in producing a low "plant efficiency." This "plant efficiency" may be defined in various ways, such as (a) the proportion existing between the maximum capacity of the plant and the largest load it ever carries; or (b) the proportion between the actual kilowatt capacity for twenty-four hours and the largest kilowattage ever supplied during the same time; or (c) the proportion between the power equivalent of the combustible consumed under the boiler *during one run and the electrical power* actually delivered to the lines during the same time. None of these definitions include the plant efficiency of the lines and transformers, which, however, is also an important matter.

The first definition may seem to be rather unnecessary, in view of the probability that at least a man knows how much to buy, but a little consideration will show that a good many factors influence the decision of the proper-sized plant for certain conditions. For instance, the number and class of residences, stores, hotels, churches, etc., will be an approximate guide, taken in connection with the proposed rates—as to the total lighting that may ultimately be expected, and a very careful examination will very closely show what may be expected as the maximum load. Now, in both these estimates experience in the electric lighting business is necessary, and it is not business-like to buy machinery without having gone into them thoroughly. In one case that I have in mind, the ampere capacity of the plant was 750, and the heaviest momentary load at any time during the year was 620, and that lasted for just thirty minutes. It is evident that at no time was the load more than 83 per cent. of the capacity, and anyone who has made out a load curve will see that the average load will be about half of this, or say 45 per cent. of capacity—and this for an average of about twelve hours during every twenty-four. In this case plant efficiency was low, and imposed a constant loss that the best operation in the world could not avoid, but that good preliminary engineering and design could and probably would have. It is not merely the unnecessary capacity of the dynamos alone; but the whole plant—engines, boilers, lines, etc.—were originally made too large. Inquiry elicited the facts that it was purchased and installed on the advice of the agents of the two manufacturing companies who supplied the engine and generators, etc. Definition (a) takes into consideration merely the actual total capacity of the plant, without reference to its division into units or to their arrangement. Definition (b) relates more specially to a plant where current is sold by meter; but (c) takes into account not only the total capacity, but also the manner in which this total is subdivided into units. This subdivision may seem a rather unimportant matter. To a person who operates an electric light and power plant as a business investment it is just as important as anything else; and the man who buys on efficiency rather than on price will admit the soundness of the claim, because it rests *directly on machine efficiency*. Illustrations from actual cases will have more point than purely theoretical discussion. Taking therefore the above case—the load line for the night that gave the highest maximum for the year was as in diagram. Maximum



620 amperes; minimum 160 amperes, and whereas the maximum was on for half an hour, the minimum was on for 5 hours. Is the subdivision into units of no importance in the above case? The minimum lasted one-third of the entire run, and was therefore an important consideration. The plant was a D.C. 3-wire one, divided into two 170 ampere machines, and two 200 ampere ones, with two long stroke engines of 120 and 65 h.p. at 80 lbs. steam, ½ cut-off. The engines belted on to a shaft through clutch pulleys, and the shaft itself was divided in two by a clutch coupling. The engines were so *arranged* that the 65 h.p. drove that end of the shaft off which were belted the two 160 ampere dynamos, while the 120 h.p. belted on to the shaft driving the two 200 ampere machines; the clutch coupling of course permitted the running of the entire plant as one. The machines were over compounded 10%, giving 120 volts at full load. Now let us analyze the working of the station on the night of the given load line. From 4 p.m. to 5 p.m. there were about 400 amperes, just enough for the two 200 ampere machines, which we will designate XX, (the others being YY). The kilowattage therefore was 48,000—or 64 h.p. Allowing XX an efficiency of 90%, required nearly 71 h.p. to drive them, not taking two belt losses into account. This was closely the power of the 65 h.p. engine, *but running this engine necessitated running* the entire shaft, and the two empty YY dynamos. So that the 120 h.p. engine had to be used, and had to run on about 80 h.p. or 66% load—not very efficient. At 5 p.m. the load was above the capacity of the XX machines, so the YY's were *thrown in* as well, with a total combined capacity of 750 amperes. Thus from 5 p.m. to 10 p.m. the percentage of the load to the capacity of the machines varied gradually from 53% to 83%, and then back to 53% again. *Looking at the engine plant during the same time*: at 5 o'clock the 120 h.p. engine was running on about 65% load. When 550 amperes were reached, this engine was about properly loaded, counting dynamo efficiency at that point as 85%, and allowing for belts and shafting. At this point, therefore, the 65 h.p. engine had to be thrown in; so we now have engines to a capacity (economical) of 185 h.p. doing about 120 h.p., again 65%. From now—6.30 to 8.30 p.m. the total load carried by the engine plant varies from 65% up to 73% and back to 65 again. From 8.30 (at which point the small engine is thrown out) to 10 p.m. the 120 h.p. engine runs on a percentage falling from about 100% down to 65%. Now returning to the generators at 10 p.m. XX have a 100% load falling to about 75% at 11.15 p.m. There the YY machines are thrown in instead, with a load dropping from about 100% at 11.15 down to about 50% at midnight, which

percentage is kept for five hours, till 5 a.m., and then rises gradually to about 72%. During this period, from 10 p.m. down to about 11 p.m., the 120 h.p. engine must be run because the other would hardly have the power; it runs on a percentage of load falling from 65% down to about 58%. At about 11 p.m the 65 h.p. will take care of the load and from now on to 7 a.m. it can run with percentage of load falling from about 100% down to 50%, shortly after midnight, keeping it up till 5 a.m., and then gradually rising to about 75%. For clearness sake I give a diagram showing the percentage of full load at which the two parts of the plant operated, taken from the above figures; the percentage taken being that of the load at any moment relative to the full capacity of such machines as were actually used to give it



A study of these diagrams will be interesting. Take No. 2. For just two hours during fifteen hours were any dynamos running at full load, and therefore at full efficiency. For about five hours the combined dynamo plant had an average of about 75% of full load, and therefore an efficiency of about 85%. For another five hours the YY dynamos had above 50% load, and an efficiency therefore of about 80%. Take diagram No. 3. During the whole fifteen hours' run, it will appear at a glance, that the steam plant was little more than half loaded. The efficiency of a steam plant is not very high under the most favorable circumstances; what it is under the conditions outlined I leave to each one to determine for himself. It may be thought that this is a special case selected as a horrible example. I beg to state that it is a very fair sample of the kind of engineering that results from the designing of power plants being left to those interested in the sale of machinery. I might give illustrations from a score of such plants in which the application of principles derived from the experience of electrical engineers would have had the most beneficial effects, if they had been applied to the preliminary engineering and design. There are some very obvious morals pointed by diagrams 2 and 3. About the most so is the advisability of designing a plant (both as regards steam and electrical machinery) with reference to the minimum load, quite as much as the maximum. Another is that the full load efficiency of machines is not of such great importance as the half load. Of course, in such a plant as the above, it is possible to improve matters by varying steam pressure in accordance with load, and allowing engines to work up to half stroke; but this will simply be an expedient, and what I particularly desire to point out is that preliminary engineering is of even more importance than good operation, because it depends on design whether the plant (not individual machines) will be efficient or not.

But, while preliminery engineering design has very great influence on subsequent economy of operation, the business policy outlined from the start has almost as great. This has to do with rates for lighting and power for the various different classes of consumers, rebates, lighting areas, method of collection, method of purchase of supplies, and many such points. It has always appeared to me that rates for incandescent lighting are capable of being greatly reduced. Instead of placing them at such figures as that even very small houses can take light, they are generally so high that only the best can afford it. I am quite convinced that in many plants a 20% cut in rates would be compensated for by a more than a counterbalancing rise in business; and in this I speak from experience derived from some plants that I am now managing. The rate question—and the other as to who is to do the wiring, the customer or the company—and some others can be altered from time to time; but the plant, once in, has got to stay. Mr. Armstrong says truly that "there is to-day no industry representing an equivalent money investment on a possibility of public service which is so generally managed by men who know nothing about it. The reason is not far to seek. The electric lighting industry is of comparatively recent date, and it is not such a very long time ago since first it began to be discovered that it was susceptible of being specialized. The growth and development of the business, and the competition of rival illuminants, has had the effect of evolving a new class of engineer—the central station manager—and as time goes on and electric lighting business is better studied the new class of engineer will become a necessity, and investors will recognize his importance. The time is surely coming when central station owners will require some better qualification in their manager than the willingness to work for $30 per month.

TRADE NOTES.

The Stevens Manufacturing Co., of London, Ont., have recently closed contracts for a 500 light plant for the town of Brussels, 500 light plant for Blyth, and 60 light arc plant for Lucknow.

Sadler & Haworth, belting manufacturers, of Montreal and Toronto, have just furnished the Hull & Aylmer Electric Railroad with two double leather main driving belts one hundred and thirty feet long and thirty-six inches wide.

The Robb Engineering Co. are building two 300 horse power tandem compound engines, one for the Halifax Electric Tramway Co., and the other for the St. John Railway Co. This makes five of these engines sold to the Halifax Company.

The Kay Electric Co., of Hamilton, have completed the installation of an electric light and ventilation plant for the Ontario Agricultural College, Guelph. This firm have also recently furnished a 15 h.p. motor for the Shipe Wood Rim Co., of Toronto, a 250 light generator for W. Davidson, and one for Donald Fraser, of Fredericton, as well as several motors for Ottawa and other eastern points.

The new lumber mills and grounds of Messrs. D. & J. Ritchie & Co., at Newcastle, N. B., have been equipped with an electric light plant by John Starr, Son & Co., Ltd., Halifax. The installation consists of about 200 incandescent lamps of 16 and 32 c.p., and by it the output of the mills will be much increased. Messrs. Starr make a specialty of installing electric plants in lumber factories, and many of these in Nova Scotia and New Brunswick have been equipped by them.

The Boiler Inspection and Insurance Company, of Toronto, have made a new departure, namely, the inspection of electrical dynamos and motors in Montreal. Mr. R. A. Ross has been retained as consulting engineer, and skilled inspectors will make periodical inspections and keep the machinery in proper running order. By this means the risk of having the power supply stopped is greatly lessened, while the annual cost of maintainance is a fixed sum and can be better provided for. The company anticipate considerable business in this direction.

The Packard Electric Co., of St. Catharines, Ont., were compelled to operate their factory day and night during the month of June in order to supply the demands of their customers for lamps and transformers for the Jubilee celebration, while many orders remained unfilled. It is learned that Packard lamps were exclusively used in the decorations at the Parliament Buildings at Ottawa. The new type "L" transformer was the one principally used for the above purpose. One unique feature of this transformer is that it requires but one cross-arm upon the pole, and does not require any separate hangers, the arrangement for hanging being permanently attached to the transformer.

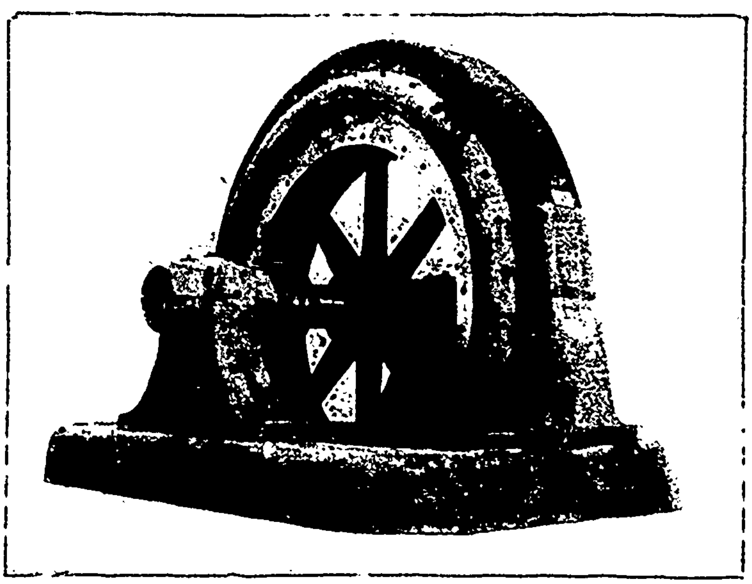
The Goldie & McCulloch Co., of Galt, Ont., advise us that they have lately made the following sales of machinery: Wm. Doherty & Co., Clinton, 100 h.p. "Wheelock" engine; Methodist Book & Publishing House, Toronto, 85 h.p. "Wheelock" engine, with shafting, pulleys, friction clutches and couplings; The C. P. R. Co., for elevator at Owen Sound, 400 h.p. "Wheelock" engine with two steel boilers, condenser and all connections; Jacob Zurbrigg, New Hamburg, 60 h.p. "Ideal" engine and boiler; Toronto Electric Motor Co., Toronto, 35 h.p. "Ideal" engine; Gravenhurst Sanitarium, Gravenhurst, 40 h.p. "Ideal" engine; McGill University, Montreal, 100 h.p. "Ideal" engine; Geo. Munro, Thamesville, 60 h.p. steel boiler; Wingham Electric Light Co., Wingham, 68 h.p. "Ideal" engine, with 75 h.p. boiler and all connections; Smuggler Gold Mining & Milling Co., Fairview, B. C., 25 h.p. engine and 30 h.p. boiler; Johnson Electric Co., Toronto, 60 h.p. "Ideal" engine and boiler; New Hamburg Mfg. Co., New Hamburg, six locomotive fire box boilers; lot of milling machinery to Plattsville Milling Co., Plattsville; The R. Forbes Co., Hespeler, woollen mill machinery; S. Larue, Mountain, heading turner; Findlay Young, Killarney, Man., 85 h.p. "Wheelock" engine; Wm. Carey & Son, Windsor, N.S., lot of wood-working machinery; Wm. Mason & Son, Ottawa, wood-working machinery; Ferguson & Pattinson, Preston, six hydrants; The Tillson Co., Tilsonburg, flour mill machinery; Jas. A. Wilson, Cantley, Que., complete sawmill outfit, engine, boiler, sawmill machinery, and shafting; John Phillip, Grand Valley, 80 h.p. "Ideal" engine; Auld Bros., Shetland, a lot of mill machinery.

THE REVOLVING FIELD TYPE OF ALTERNATING CURRENT GENERATOR.

The development of the revolving field type of alternating current generator, and the standardization of a complete line, both for the monocyclic and three-phase systems, has of late occupied the attention of the engineering department of the General Electric Company, with successful results. The alternators are designed for the standard frequency of 60 cycles, and for pressures ranging between 500 and 5,000 volts.

The machines are built on the same lines as the Canadian General Electric type of induction motor. The stationary armature is built up of laminations stamped from specially selected and tested steel plates. Ample spaces are left for ventilation, and the coils are covered and protected by shields. The base of the armature is of smooth cast-iron, and the pedestals supporting the bearings are provided with spherical seats, which support the boxes and allow of perfect alignment.

The removal bearings are, of course, self-oiling, with the oilways so cut as to give an even flow of oil from the resting places of the rings in the shaft to the end of the bearings where the oil returns to the reservoir.



C. G. E. Alternating Generator, Revolving Field Type.

The revolving field is extremely simple of construction. It is merely an iron spider mounted on a shaft *carrying a soft-steel* ring serving as a yoke for the pole pieces, which are made up of laminated iron with polar projections. The field coils are removable, and in the larger sizes are wound with flat copper strips placed edgewise, to allow of free egress from the coils of any heat. The armature can be moved along the base to facilitate access to fields and armature winding.

With a high efficiency, these alternators combine good inherent regulation, and can be, if desired, compounded for accurate automatic regulation. Such compounding in certain cases is not necessary to convenient operation, and may be omitted. When compounded a commutator is mounted on the shaft and rectifies current supplied from a series transformer in the main circuit. These compounding devices are not, however, included in the generator, properly so called. They come under the head of extras. The temperature of the armature and the field windings does not rise above 45 degrees centigrade above that of the surrounding atmosphere.

The new type of generator is not, of course, intended to displace the revolving armature type. The revolving field type has its own special field of usefulness. It is free from high-potential collector rings and commutators, the only collector rings being the two used to bring the exciting current to the revolving fields. The high-potential part of the alternator the armature being a stationary structure, can be wound and insulated for much higher pressures than is desirable for revolving armatures, and the current can be fed directly into the line without the intermediary of step-up transformers. All the high-potential terminals are effectually insulated.

The revolving field alternators can be wound for the two-phase system when desired, and when so wound are so arranged that armature coils can be cut in or out to give independent regulation of the two phases.

During the past year the Canadian General Electric Company has sold a number of machines of this type, some for belt drive, but principally for direct connection to water wheels. The illustration shows a 750-kilowatt, 40-pole, three-phase machine, running at 175 revolutions and delivering current at 4,400 volts. It is one of twelve which will be used on the Lachine Rapids installation.

Two more generators of the same type and size are now being constructed for the 30-mile transmission of the West Kootenay Power & Light Company. For very low potential work this type is especially well adapted, two of 150-kilowatt capacity each being in use at the Wilson Carbide Company's works at Merritton, Ont.

HOW MANCHESTER IS LIGHTED.

The corporation of Manchester, England, owns and operates a large electric lighting system, which has recently been fitted with the largest storage battery in the United Kingdom. It is not located in the central station where the current is generated, but about a mile *distant, in a special* sub-station. The current is distributed in Manchester by what is known as the five-wire system, a modification of the method followed by the Edison lighting companies in this country. The current as it is taken from the wires is of insufficient voltage to charge the battery, and is accordingly transformed by a motor-generator to a current of 510 volts. The battery consists of 224 large cells, each containing 73 plates. The cells are made of heavy sheet lead, and are carried on iron and timber stands. The entire installation is divided into four distinct batteries of fifty-six cells each, coupled to the five-wire network of mains. Each of the batteries thus formed is further subdivided into two parts, one consisting of the battery proper of forty-four cells, and the other a regulating battery of twelve cells. All the cells are placed in five arched vaults under a street, three of the vaults containing the main batteries, the fourth being used for the regulating cells, and the fifth holding the motor-generator and switchboard. The normal maximum rate of discharge of the plant is 600 amperes from each of the four batteries, or a total current of 2,400 amperes delivered at 100 volts to the mains. The average rate of discharge is 300 amperes, which is also the normal charging rate. The entire night load after midnight is taken by the cells, thus allowing a large reduction in the number of men employed from 10 o'clock in the evening until 6 on the following morning, while on Sundays relief is also given to the men working during the day, the battery taking the day-load up to 4 o'clock in the afternoon in addition to the load of the previous night.

ELECTRICAL DEVELOPMENT IN AUSTRALIA.

MR. J. S. Larke, of Sydney, N. S. W., writing to the Dominion government under date of April 10th, 1897, gives the following particulars of electrical matters in Australia :

ELECTRICAL WORK.

The railway construction branch of the Department of Public Works, of the government of this colony, will shortly complete plans and specifications for an electric street railway for this city.

The city of Sydney last year secured powers to effect a loan of a million and a half dollars to erect plant for lighting the city by electricity. Pending the conclusion of negotiations with the government respecting a common supply for lighting and street railways, nothing has been done in the matter. It is possible that within a short time tenders will be asked for both of these important works, and if Canadian electrical companies desire to compete it is advisable that they should watch for the advertisements. It is probable that the advestirements will appear in London and this city at the same time time, so that the London advertisements would be first seen in Canada. There will be, undoubtedly, an extension of electrical works in Australia, at a much more rapid rate than has hitherto been the case. Melbourne has a very effective cable system, but with that and another exception all the cities of the colonies are served by horse or steam lines or busses, when an electrical system would be preferable.

At the request of a Canadian company I have made inquiries into the consumption of carbons in these colonies, with the following result :—

CARBONS.

The total consumption of carbons in Australasia is estimated to be about three millions per annum. In New Zealand and Victoria electric lighting has made greater progress than in this colony.

No approximation of the sizes used can de given, but in the Railway Department of New South Wales the following are the sizes, number of each sort, and prices paid in 1896 :

						s.	d.
Brockie-Pell,	9 in.,	13 mm.,	solid ;	12,000	per hundred...	3	10
"	15	15	cored,	5,000	" ...	10	6
"	15	13	"	8,000	"	7	0
"	12	18	"	10,000	" ...	10	0
"	9	18	"	2,000	per hundred ft..	7	9
"	12	15	solid ;	4,000	" ..	8	0
"	9	15	"	5,000	" ..	6	6
"	15	18	cored ;	2,000	" ..	12	6

Brush, 12 in., 11 mm., solid, coppered, 12,000 per thousand feet, £3 7s 6d.

The thickness is given as in the case of all carbons here in millimetres. The Post Office Department uses 12 x 12 and 12 x 18, 13 x 9 and 13 x 15. As a rule the Post Office Department and electric light companies paid slightly higher rates than those paid by the Railway Department.

The following letter from the Department of Customs, Melbourne, gives the information respecting Victoria :—

"In reply to your enquiry of the 16th instant, relative to electric carbons, I beg to state that the quantity of goods imported is not available, the item being included under the heading of 'Electrical Goods.'" Those used by the government of Victoria are all tendered for in the colony.

The Railway Department uses 11 millimetres solid and cored carbons, for which they pay under the present contract, £2 per 1,000. Brush carbons the same size are also bought for £2 per 1,000, all of ten ampere currents.

The Postal Department uses the following under present contract :—

12 mm. carbons, cored, 12", 8,000 at £2 14 0 per 1,000.

12 mm. carbons, plain, 7", 2,333 at £2 14 0 per 1,000.

13 mm. carbons, cored, 15", 2,500 at £2 18 0 per 1,000.

19 mm. carbons, cored, 13", 1,083 at £2 18 0 per 1,000.

11 mm. carbons, plain, 12", 2,000 at £2 10 0 per 1,000.

9 mm. carbons, plain, 9", 750 at £1 10 0 per 1,000.

Those supplied at the Parliament House are the "Conradty," at £4 4s 0d per 1,000 ; size, 7 16 in. x 12 in. moulded.

The city corporation uses Fooke's and Hartmann's under the present contract ; size, 7 16 in. x 12 in. (11 mm.), the yearly estimate being 600,000 at £1 12s 10d per 1,000.

The estimated number used annually by the various government departments in Victoria and the city council is 750,000.

I think the demand for carbons will increase, but it is not doing so rapidly just now.

The carbons used here are mainly imported from Austria. United States makers have sent some here, but they have made no headway. The opinion seems to be that they are much higher in price and inferior in quality to the Austrian.

ANNUAL MEETING OF THE ROYAL ELECTRIC CONPANY.

THE Royal Electric Company held their annual meeting in Montreal on July 8th, at which the following directors were re-elected : Hon. J. R. Thibaudeau, president ; D. Morrice, vice-president ; F. L. Beique, A. Brunet, Allan Macdonnell, F. S. Holt, Edwin Hanson, J. A. L. Strathy, and Robert Cowans.

The annual report showed the revenue for the year to be $900,348.10, and the expenditure for labor, materials, operation, maintenance and general expenses, $656,467.99, leaving a gross profit of $243,880.11. Deducting interest and fixed charges of $43,245.83, left a net profit from business of $200,634.24. From this net profit four quarterly dividends of 2 per cent. each were declared.

Additions and improvements to the factory and its equipment to the value of $58,210.23 were made during the year, and on lighting stations, lines and installations and general construction the sum of $99,880.30 had been expended for a like purpose. The total value of the additional equipment was thus $158,090.53.

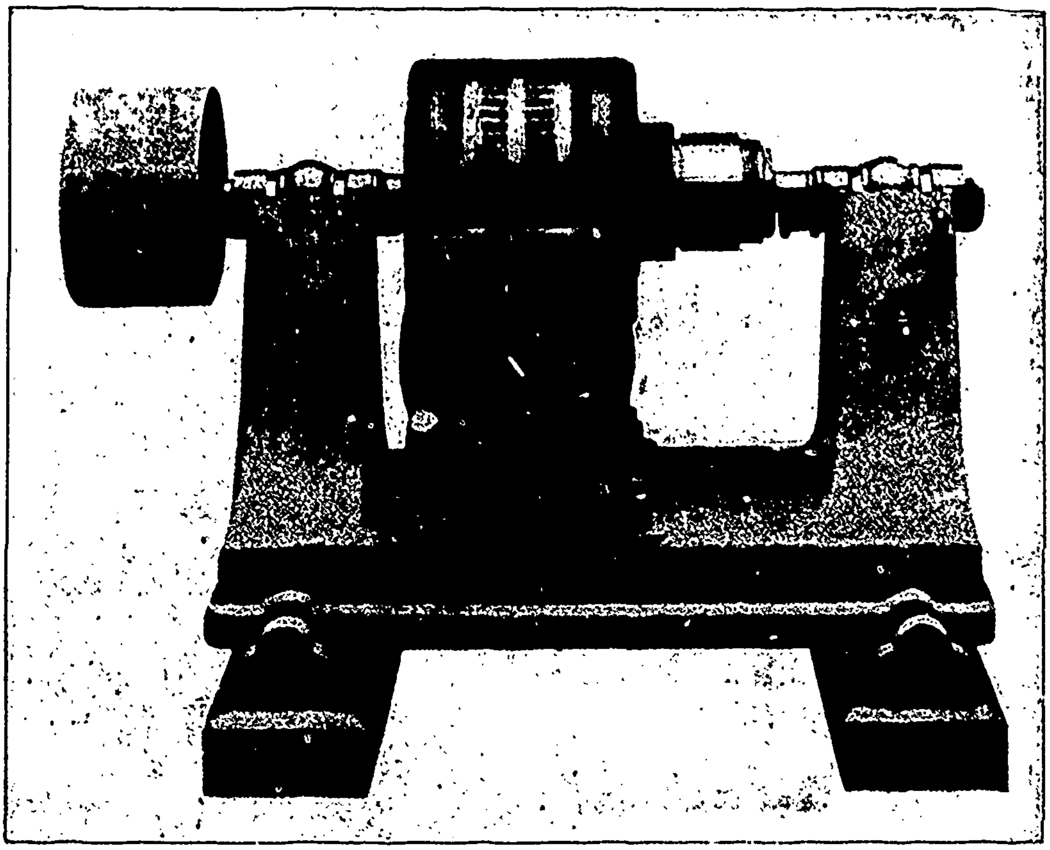
In connection with the placing of new generators and switchboards in the incandescent lighting station, a work completed in November last, it was noted that the saving in fuel resulting therefrom amounted to 4,015 tons.

During the Queen's Jubilee nearly 20,000 incandescent lights and about 200 arc lights were provided by the company in addition to the requirements of regular customers. During the month of April last arrangements were completed for placing the balance of the authorized capital stock of the company, namely, $250,000 par value, in London, England.

DIRECT CURRENT MULTIPOLAR DYNAMO.

The accompanying illustrations represent a new type of direct current multipolar dynamo, manufactured by the Electrical Construction Company, of London, Limited, and specially adapted for isolated lighting plants. Among other features the manufacturers claim for this machine the following *points of merit*:

A minimum number of parts are employed in its construction, and all the mechanical details are so perfect in design that absolute interchangeability of parts is obtained.



OPEN VIEW DIRECT-CURRENT MULTIPOLAR DYNAMO.

The field magnets are made from a special quality of cast steel, and the metal is so placed, and so used, that there is no choking of lines at any point of the magnetic circuit; nor has any attempt been made to work the magnetic frame to its full limit of saturation.

The shunt and series coils are wound up separately, and are secured to the pole pieces by suitable clamps.

The slotted type of armature is used on this machine. The coils are so designed and placed in the armature that they are interchangeable at every point. They are of equal length and ample conducting capacity.

The commutator is very large and designed for the use of carbon brushes. The carbon brushes are so constructed that the contact between the carbon *and the machine terminals is through* a flexible conductor strip clamped securely to the carbon brush. This design absolutely prevents arcing between the brush and its holder.

NEW TYPE DIRECT-CURRENT MULTIPOLAR DYNAMO.

The bed-plate is made in one piece, and is very stiff and strong; it supports the barrel bearings of the armature, which are of the self-aligning and self-oiling type.

The apparatus is made in the following sizes, viz., 4, 7½, 15, 20, 30, 40 and 60 k.w.

The Electrical Construction Company also manufacture a complete line of direct-current stationary motors, in sizes from one to one hundred horse power, and have a fully equipped repair shop. Their office is at 90 York street London, Ont.

The city council of Grand Forks, B. C., will borrow money with which to purchase an electric light plant.

The town of Owen Sound, Ont., have accepted an offer made by the Owen Sound Electric Light Company to supply 30 lights at $75.00 per year, running under the moonlight schedule.

The motor of the new swing bridge at Hamilton Beach burned out recently, and the bridge had to be swung by hand. James Eustace, the young man who was operating the bridge when the motor burned out, had a narrow escape, his watch chain being fused and his face singed. The accident was *caused in a peculiar manner. When Eustace was in the power* house his watch chain fell across a wire, making a short armature and sending up a blaze several feet into the air.

WESTERN ONTARIO LIGHTING PLANTS.

Below will be found brief descriptions of several electric lighting plants in Western Ontario, from the perusal of which some points of instruction may be gathered.

DRESDEN ELECTRIC LIGHT PLANT.

The old plant in this town was totally destroyed by fire in August, 1896, and the present plant was installed in September following. It is located in a detached brick one-story building, 20 x 40 feet, and is an alternating system, a Thomson-Houston generator, with speed of 1,500 revolutions, furnishing current for nine arc lights and about 300 incandescent lamps. The switch-board is fitted with Canadian General instruments of latest design. One of the special features of this plant is said to be the very satisfactory service to patrons.

The belt is run direct from engine to dynamo, no counter-shafting being used. The steam power is supplied by a 95 h. p. boiler and an 85 h. p. Leonard Ball automatic cut-off engine. The plant is under the efficient management of Mr. W. F. Jameson, and is owned by Mr. J. E. Gordon, the proprietor of the Dresden stave mills.

ST. MARY'S ELECTRIC LIGHT PLANT.

This plant, owned and operated by Mr. L. H. Reesor, is furnishing a very satisfactory service to the citizens of St. Marys. The company have installed now about 1,000 incandescent lights of 16 candle power. Their power house is conveniently situated in a central locality and is equipped with a National 500 light machine and two 50 Ball arc generators, with National switch-board and instruments.

In connection with the plant there is a well equipped stock room, provided with shelving and compartments, and well stocked with all the necessary parts required for repairs. Power is supplied by two 50 h. p. turbines, supplemented by a steam engine to maintain an equal running power. Mr. W. J. Stevenson is the electrician in charge.

FOREST ELECTRIC LIGHT COMPANY.

The electric light plant at Forest is owned and operated by Messrs. Hamilton & Proutt, the well known planing mill proprietors. It is located in a commodious brick addition to their mill, and is equipped with 800 light Royal dynamo for their incandescent light system, and a 50 arc light Thompson gnnerator for arc street lamps. A special feature of this plant is a handsome marble switch board, 6 x 4 ft., fitted with General Electric instruments. The mill engine supplies the necessary power. This company are at present furnishing about 250 incandescent lamps and 11 arc lights.

PETROLIA ELECTRIC LIGHT, HEAT AND POWER COMPANY.

The officers of the above company are as follows: G. V. Ashworth, president; Walter MacDonald, vice-president and secretary; W. H. Ashworth, manager. The plant was installed and commenced service on January 15th, 1895. The power house is a frame structure 35x70 ft., with flat roof. The driving plant consists of two boilers, one of 100 h.p. and the other of 150 h.p. capacity, and a 100 h.p. Wheelock condensing engine, with thirteen foot fly-wheel. The generators are a Thomson-Houston 1,000 light alternator, a 50 light arc, and a 350 light Royal, for use when overloaded, the switchboard instruments being from the Canadian General Electric Co. Their service at first consisted of 30 arc lights and about 200 incandescent lamps, but at present they are furnishing 39 arc lights, with a candle power of 1,200, and 1,700 incandescent lamps.

Electric power from this plant is used in oil pumping, this being the first instance in the world where electricity has been used for that purpose. During last July the company put in a 15 k.w. General Electric generator of 500 volts, to furnish power for a motor at a batch of sixteen wells, and which has given every satisfaction. The increasing number of wells being bored will lead to its more general adoption, as its adaptibility and cheapness over steam power has now been proven.

Owing to scarcity of water this plant has a very novel condensing system, making use of four tanks, fifty feet in depth by twelve feet in diameter, connected by syphon arrangement, the pump for heater being fed from nearest tank by three inch pipe, and the water from condenser being carried by pipe and open trough to farthest tank.

This company are oil producers as well, having four wells in their yard which they operate.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.

NOTE.—Secretaries of Associations are requested to forward matter for publication in this Department not later than the 25th of each month.

TORONTO NO. 1.

The regular meeting of Toronto No. 1 was held on July 7th in Engineer's Hall, 61 Victoria street. After the regular business had been dealt with, Bro. E. J. Philip installed the following officers for the ensuing year: President, G. C. Mooring; vice-president, T. Eversfield; recording secretary, J. W. Marr; ; financial secretary, J. Bain; conductor, G. Thompson; door-keeper, T. Cadwell; treasurer, S. Thompson.

MONTREAL NO. 1.

A largely attended meeting of Montreal No. 1 was held in their hall on Craig street on June 17th, the occasion being the twelfth annual meeting for the election of officers. The following were elected: President, Wm. Smyth; 1st vice-president, Wm. Bowden; 2nd vice-president, P. McNaughton; recording secretary, J. O'Rourke; financial secretary, Harry Nuttall; corresponding secretary, Thos. Ryan; treasurer, G. Jones; librarian, Wm. Ware; conductor, J. Morrison; door-keeper, James Wilson; trustees, J. J. York, O. G. Granberg, George Hunt. A large amount of business was transacted. Several new by-laws were passed and others altered, tending towards the better government of the association.

HAMILTON NO. 2.

At the regular meeting of Hamilton No. 2, held a fortnight ago, the following officers were installed by the past-president of the executive, Bro. Blackgrove, of Toronto No. 1: President, W. Norris; vice-president, G. Mackie; recording secretary, J. Ironside; financial secretary, J. Carroll; treasurer, W. Nash; conductor, J. Johnston; door-keeper, T. Carter. The retiring financial secretary, E. Nash, was presented with a handsome secretary by past-president R. Mackie, on behalf of the association.

LONDON NO. 5.

The election of officers took place at the last meeting of the above association, with the following result: D. G. Campbell, president; B. Bright, vice-president; W. Meaden, treasurer; W. Blythe, secretary, W. Burkholder, conductor; R. Evans, doorkeeper. The officers were installed by the retiring president, Bro. G. Risler. The subject for discussion was "The Gain in Power Due to the Expansion of Steam in a Cylinder," which was ably handled and illlustrated. A number of engineering questions are being prepared for competition by the members, for the best solution of which a prize will be given.

KINGSTON NO. 10.

Kingston branch installed new officers at their last meeting, past-president S. Donnelly being master of ceremonies. The officers now are: F. Simmons, president, re-elected; C. Asselstine, vice-president; J. L. Orr, secretary; C. Selby, treasurer; W. Woodrow, conductor; R. Burgess, doorkeeper; S. Donnelly and C. Blomley, trustees. F. Simmons and C. Selby were appointed delegates to the annual convention to be held in Brockville next month.

EDUCATIONAL DEPARTMENT

INTRODUCTORY

After mature deliberation the publisher of this journal has decided to devote a certain amount of space each month to what may be termed an Educational Department, wherein both mechanical and electrical formula and mathematical problems will be discussed, illustrated, and as far as possible rule and example given. At the request of the editor, I have with pleasure undertaken to contribute to this department regularly each month, and before discussing actual mathematical problems, wish to briefly introduce the subject at issue.

The primary object of this department is chiefly to increase the value of an already valuable paper, by placing in the hands of every engineer who has any knowledge of the rudimentary principles of mathematics, such matter as will enable him by a little study to master the most intricate mechanical and electrical formula. Many of our most valuable engineering works and publications from time to time contain formula that is in many cases but vaguely understood, and very often entirely misunderstood, thus rendering an otherwise valuable work practically valueless to the reader.

Just at what particular point our calculations should commence became a matter of serious thought, and past experience had to be carefully considered, bearing in mind the fact that there are many really good engineers whose early education has, through force of circumstances, been deficient, and many others who, through lack of opportunity, have not been able to review their early education for years. Knowing by observation and experience the great necessity of having a thorough elementary education before attempting to digest and calculate problems, and the almost utter impossibility of the student arriving at a satisfactory conclusion of his studies without a thorough knowledge of the principle of mathematics involved, I have decided to commence at a point and carry out the programme outlined in this journal—commencing at the foundation and advancing by easy stages until the principles underlying the most obtuse and difficult formula can be readily explained and easily understood. The advantages to be derived from an education of this kind, coupled with practical mechanical ability, is too well understood to require comment.

The programme which has been outlined for the succeeding nine months will embrace

DECIMAL FRACTIONS—Definitions and explanation of principles of, and method of reduction to common fractions, and vice versa.
SQUARE AND CIRCULAR MEASURE—Definition and explanation and practical demonstrations of.
CUBICAL AND CYLINDRICAL MEASUREMENTS—Definitions and explanations of, with practical hints.
SQUARE AND CUBE ROOT—Definitions and explanations of.
SAFETY VALVE CALCULATIONS—(Spring and Lever Types)—Principles of, with practical demonstrations.
BOILER CONSTRUCTION—Stays, rivets, joints and seams, iron and steel plate—strength of, with formula and practical demonstrations.

It is not the intention to fill these columns with a mass of figures hastily compiled without reference to any particular object; on the contrary, every problem will be carefully thought out, and only such information given as will be of use to you, and an effort will be made, based on experience and a knowledge of the requirements, to make this series of tests complete in every particular.

WM. THOMSON.

[ARTICLE III.]

PRACTICAL MEASUREMENTS.

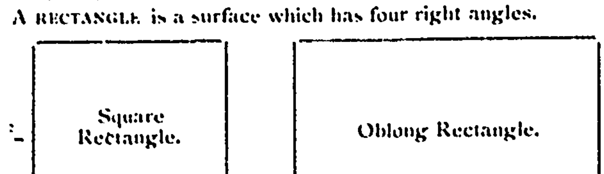
THE practical measurements herein referred to and treated as being of especial benefit to engineers, are distinguished as measures, of surface, of volume and of capacity.

MEASURES OF SURFACE OR SQUARE MEASURE.

SURFACE is that which bears reference to length and breadth only, depth or thickness not being considered.

The AREA of a surface is the number of square feet, inches or yards, etc., that such a surface contains.

A RECTANGLE is a surface which has four right angles.



Rule: To find the area of a rectangle or square, multiply the given breadth by the given length, and the product will be the area.

Rule: To find the required length of either side of a rectangle or square, divide the given area by the given length of known side.

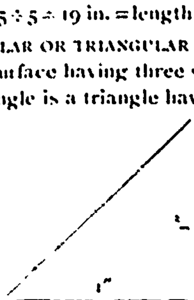
Example: Find the length of a surface whose area is 95 sq. in. and breadth 5 in.

$95 \div 5 = 19$ in. = length required.

IRREGULAR OR TRIANGULAR MEASUREMENTS.

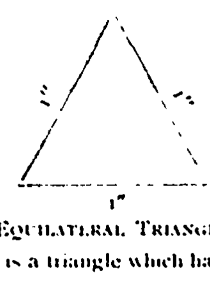
A triangle is a surface having three sides and three angles.

An Isoceles triangle is a triangle having two equal sides.



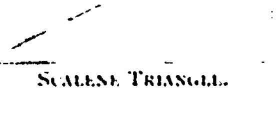
ISOCELES TRIANGLE.

An Equilateral triangle is a triangle having three equal sides.



EQUILATERAL TRIANGLE.

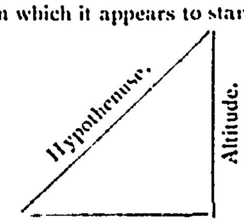
A Scalene triangle is a triangle which has no two sides equal to each other.



SCALENE TRIANGLE.

The base of a triangle is the line which intersects the other two lines at the point greatest distant from the vortex.

The lines representing the base and altitude are perpendicular to each other, and if a triangle be placed vertically, the base will be the side on which it appears to stand.



Rule: To find the area of a triangle, multiply the base by one-half the altitude, and the product will be the area.

Rule to find either the altitude or base of a triangle, area, and one side being known: Divide the area by one-half the given dimension, and quotient will be required dimension of other side.

Example: Find the required length of the base of a Scalene triangle whose altitude is 6 inches and area equals 36 inches.

$36 \div$ by one-half altitude $= 36 \div 3 = 12''$, required length of base.

CIRCULAR MEASUREMENT.

A circle, as geometrically defined, is a plain figure bounded by a curved line, all parts of which are equally distant from the centre.

The circumference of a circle is the curve which bounds it.

The diameter of a circle is a straight line that passes through its centre.

The radius of a circle is a straight line that joins the centre to a point in the circumference.

[Note: Referring to this, it follows that the radius is one-half of the diameter.]

Rule: To find the circumference of a circle, the diameter being given, multiply the given diameter by 3.1416, and the product will be the circumference.

Rule: To find the diameter of a circle, the circumference being given, multiply the given circumference by the decimal .3183, and the product will be the diameter.

Rules: To find the area of a circle, the circumference, radius or diameter being known,

Multiply the circumference by one-fourth the diameter, and the product will be the area;

Or, multiply the square of the radius by 3.1416, and the product will be the area;

Or, multiply the square of the diameter by .7854, and the product will be the area.

Example: Find the area of a circular bolt 3.1416 inches in circumference.

Circumference $\times$ .3183 equals dia.

$3.1416 \times .3183 = 1''$ diameter,

$1 \div 4 = .25$ = one-fourth dia.

$3.1416 \times .25 = .7854$ sq. in. area.

Example: Find the area of a circle whose radius is one-half inch.

Radius squared $\times$ by $3.1416 =$

$.5 \times .5 = .25 \times 3.1416 = .7854$ sq. in. area.

Example: Find the area of a circle whose diameter is 1 inch.

Diameter squared $\times .7854 =$

$1 \times 1 = 1 \times .7854 = .7854$ sq. in. area.

A review of these examples will prove clearly to the student why constant .7854 is used in formula when it is necessary to find area of any circle, and needs no further comment.

MEASURES OF VOLUME OF SOLID BODIES OR CUBICAL MEASUREMENTS.

Cubical measurement includes length, breadth and thickness being taken into consideration.

The process of finding the cubical contents of a solid body is similar to finding the area; in fact, area multiplied by thickness will give cubical contents.

MEASURES OF CAPACITY AND CUBICAL CONTENTS OF SQUARE AND CYLINDRICAL BODIES.

Measures of capacity embrace measurements of barrels, tanks, bins, boxes, cylinders, etc., etc.

The liquid gallon of the United States contains 231 cubic inches.

The Imperial or British gallon contains 277.274 cubic inches.

A cubic foot of water contains approximately 6.25 Imperial gallons and weighs 62.5 pounds avoirdupois at 62° F. under atmospherical pressure.

Rule: To find capacity of a square tank, dimensions of which are known, multiply length by breadth and product by depth, and result will be cubical contents.

Example: Find the number of Imperial gallons of water a rectangular tank will contain, inside measurement of tank being length 20 feet, width 15 feet, depth 3 feet 6 inches.

Formula: $\dfrac{\text{Length} \times \text{width} \times \text{depth} \times 1728}{277.27}$ = Imperial gallons.

20′ = length.
15′ = width.
100
20
300
3.5 = depth.
1500
900
1050.0 = cubical contents in cu. feet.
1728 = cubic inches in one cu. foot.
8400
2100
7350
1050
1,814,400 = cubic inches

1,814,400 ÷ 277.27 = 6543.8 Imp. gallons,

or, when absolute correctness is not required, short method formula as follows may be adopted.

Length in feet × width in feet × depth in feet × 6.25 = Imp. gallons.

20′ × 15′ × 3′ 6″ = 1050 × 6.25 = 6562.5 Imp. gals.

Example (2): How many gallons (U. S.) of oil will cylindrical oil tank hold whose internal dimensions are: Depth 4 feet 6 inches, diameter 3 feet.

Formula:

$\dfrac{\text{Diameter squared} \times .7854 \times \text{depth} \times 1728}{231}$ = U. S. gallons.

3′ × 3′ = 9′ × .7854 = 7.0686 = area in sq. feet—7.0686
4.5 depth.
31.80 cap. in cu. ft.
1728
54950.4 cap. in. cu. in.

54950.4 ÷ 231 = 237.9 gallons oil.

Example (3): It is required to fit a tank into a recess 6 ft. wide and 14 ft. 6 in. long. Tank to be made of 3 in. plank and contain 5000 Imperial gallons of water. What height should tank be so as to allow sides to project 6 in. above the water line?

First find exact internal measurement of tank, then exact quantity of water contained in each inch of depth; divide required quantity of water by this product, and add 6. Result will be required height.

Dimensions of recess are given as 6′ × 14′ 6″. Since, however, tank is to be constructed of 3 in. plank, twice this thickness must be deducted to get internal measurement of tank,

∴ 6′ − 6″ = 5′ 6″ internal width of tank.
14′ 6″ − 6″ = 14′ internal length of tank.
14′ × 5′ 6″ = 11,088 sq. inches.
11,088 ÷ 277.27 = 39.99 Imp. gals. per inch.
5000 ÷ 39.99 = 125 inches to water line.
(125 + 6) ÷ 12 = 10′ 11″ height of tank.

Example (4): A tank 1 ft. 9 in. deep, 2 ft. long and 4 ft. wide, is found to contain 70 Imperial gallons of oil. How far from the top is the oil, and what is capacity of tank when full?

Since one gallon of oil is equal to .16 cu. ft., we can here materially shorten our calculation by working decimally.

First find how many cubic feet 70 gallons are equal to by multiplying by .16.

70 × .16 = 11.2 cu. feet,

and as the tank is 2 feet by 4 feet, its base will equal 8 sq. ft.

Then divide 11.2 cu. feet by 8 sq. feet to get height of oil.

11.2 ÷ 8 = 1.4 feet height of oil.

The tank is given as being 1.75 feet high,
and the oil is 1.40 " "
then oil is 0.35 feet from the top.

0.35 feet × 12 = 4.2 inches distance from top of tank to oil.

To find capacity of tank when full, we first find cubical contents of tank in feet and then divide by .16.

1.75 × 2 × 4 = 14 ft., cubical contents of tank.
14 feet ÷ .16 = 87.5 gallons of oil in tank when full.

Example (5): If one cubic foot of coal weighs 84 pounds, what weight of coal will a car contain 30 feet long, 6 feet wide and 5 feet deep?

First find cubical contents of car in feet, then multiply by weight per cu. ft. Result will be total weight of coal.

∴ 30 ft. × 6 ft. × 5 ft. = 900 cu. feet.
900 × 84 = 75600 pounds of coal.

Example (6): How many cubic feet of steam will a cylinder contain, 18 in. × 36 in., with 5 per cent. clearance, and how many cubic feet will be used per hour if engine runs 75 revolutions per minute.

First find cubical contents of cylinder, including clearance, then multiply by strokes per minute, and this product by 60. Result will be number of cubic feet of steam consumed per hour.

18 in. × 18 in. × .7854 = 254.47 sq. in., area of cylinder.

254.47 × 36 in. = 9160.92 cubical contents of cylinder without clearance.

9160.92 ÷ 95 × 100 = 9653.6 cu. in. = contents of cylinder, clearance included.

9653.6 ÷ 1728 = 5.58 cu. feet.

5.58 × 75 × 2 = 837 cu. ft. steam per minute.

837 × 60 = 50,220 cu. ft. of steam used per hour.

PRACTICAL RULES WORTH REMEMBERING.

The diameter of a circle × by 3.1416 = the circumference.
The circumference of a circle ÷ by 3.1416 = diameter.
The radius af a circle × by 6.283185 = circumference.
The circumference of a circle ÷ 6.283185 = radius.
The square of the radius of a circle × 3.1416 = the area.
The square of the diameter of a circle × 0.7854 = the area.
The square of the circumference of a circle × 0.07958 = the area.
The circumference of a circle × 0.159155 = the radius.
The square root of the area of a circle × 1.12838 = the diameter.
A semi-circle is ½ of a circle, or 180 degrees.
A quadrant is ¼ of a circle, or 90 degrees.
A sextant is ⅙ of a circle, or 60 degrees.

Next issue will contain examples of square and cube root, and definitions of signs and symbols for algebraical formulæ.

SPARKS.

The running of electric cars on Sunday in Kingston is being protested by the Lord's Day Alliance.

The Nelson Electric Light Company has decided to increase the capacity of its plant, at a cost of $10,000.

A by-law will be submitted to the ratepayers of Vernon, B. C., to raise $12,000 for the purchase of an electric light plant.

A perfected horseless carriage, it is announced, will soon be turned out of the works of the General Electric Company, in Lynn, Mass.

The Osler syndicate is still negotiating to secure control of the Hamilton and Dundas and the Hamilton street railways. Several offers have been made, but as yet no agreement has been reached.

A proposition has been made to amalgamate the Brantford Street Railway and the Hamilton, Chedoke and Ancaster Electric Railway for the purpose of making direct connection with Paris, by way of Brantford.

The vast march of progress within one generation is strikingly illustrated by the death, only a short time ago, of Joseph Bell, the engineer who drove Stephenson's first locomotive. After escaping numerous perils on the road, he met his death by falling through an open hatch on the street. Another illustration is Sir Isaac Holden, who was a member of last parliament, and is still an active old gentleman, who invented the lucifer match.

SPARKS.

The Association of Telephone Superintendents met at Niagara Falls, N. Y., on June 16th.

The town of Dartmouth, N. S., have now under consideration offers for electric lighting.

The Toronto Electrical Works Company has been incorporated at Toronto, with a capital stock of $30,000.

A money by-law, to increase the electric light plant, was recently defeated by the ratepayers of Picton, Ont.

Mr. W. R. Burke, manager of the G. N. W. Telegraph office at Ingersoll, Ont., was recently smothered by gas.

It is expected that telephone communication between Halifax and St. John will be established within a short time.

Walter Stewart's saw mill at Lucknow, Ont., in which was located the electric light plant, was recently destroyed by fire.

Superintendent H. W. Kent, manager of the Nelson & Vernon Telephone Co., has completed a line from Rossland to Spokane.

The Bell Telephone Company will supply the town of Carleton Place, Ont., with an electric fire alarm system, at a cost of $1,000.

A by-law to grant $5,000 towards an electric railway from Perth to Lanark was defeated by the ratepayers of the former town recently.

The estate of the defunct Citizens Telephone Exchange at Waterloo, Que., has been sold to the Pare & Pare Company, of Granby.

E. J. Cuisack, of Havelock, N.B., has invented a compressed air motor for which he has secured patents in Great Britain, Canada and the United States.

The American Street Railway Association, which held its annual meeting in Montreal two years ago, will assemble in convention at Niagara Falls, N.Y., on October 19th next.

It is with regret we learn that the well-known firm of Patterson & Corbin, car manufacturers, St. Catharines, Ont., have not been prosperous of late, and that it is probable their works will be closed down.

The Taylor Hydraulic Air Compressor Company, of Montreal, elected the following directors for the ensuing year: Messrs. S. Carsley, Joseph R. Fair, George Durnford, W. L. Campbell and R. L. Murchison.

The receipts of the Toronto Street Railway Company for the month of June show a gain over the same month last year of about $7,000, the respective figures being, $92,015.16 and $85,195.13. In the former figure is included the receipts on Sundays.

The By-Town and Aylmer Turnpike Union Road Company have entered an action against the Hull Electric Railway Company, claiming $20,000 damages, and to compel the latter company to remove their line from Aylmer road to Suspension Bridge.

The C. P. R. Telegraph Company recently made a record in connection with the Queen's message to Ottawa. The message from Buckingham Palace to the Earl of Aberdeen, Rideau Hall, was sent direct by the Commercial Cable Company to Canso and from there over the C. P. R. line to Ottawa. The period of transmission, including return message, was seven minutes.

The Canadian Power Company have commenced work on its proposed power canal at Niagara Falls, Ont. This canal will be about 200 feet wide at the bottom and about 4,000 feet long, and will extend from the Chippewa Creek to the head of the Dufferin Islands. Mr. R. Paine, of Niagara Falls, who is one of the promoters, states that it is the intention to develop 40,000 h. p. at once.

A syndicate, composed of Messrs. T. G. Blackstock, J. W. Langmuir, W. Willson, W. B. Rankine, W. C. Ely, Alexander Fraser and J. M. Bostwick, have laid before the Ontario Premier a project to construct another bridge across the Niagara river, near Lewiston, and an electric belt line railway passing over the two bridges and the intervening stretches along both sides of the river.

The annual meeting of the shareholders of the Dominion Telegraph Company was held in Toronto recently, at which the board of directors were re-elected, viz., Thomas Swinyard, president; Hon. Sir Frank Smith, vice-president; Gen. Thomas T. Eckert, A. G. Ramsay, Henry Pellatt, Hector Mackenzie, Thos. F. Clarke, Thomas R. Wood, Charles A. Tinker, and F. Roper, secretary and treasurer.

Alderman Woods has given notice in the Toronto city council that he will move that it be an instruction to the city engineer, when considering the cost of establishing an electric light plant at the new municipal buildings, to also consider the advisability of installing a plant of sufficient capacity to provide for the lighting of all municipal buildings, public streets and parks, as well as the supply of power to manufacturers.

After careful investigation into the circumstances of the recent Point Ellice bridge disaster at Victoria, B.C., the jury has rendered a verdict holding the directors of the Consolidated Railway Company responsible for the lives lost. The city council was arraigned as guilty of contributory negligence and the officials of the corporation were absolved of personal responsibility. It was found that the accident would not have occurred but for the improper crowding of the cars, and also that the bridge was not constructed according to the original specifications.

The Minister of Public Works for the Dominion has made known the intention of the Government to install a complete electric light plant at the Parliament Buildings at Ottawa, at a cost of $75,000. At present the buildings are lighted by both gas and electricity, the former costing from $18,000 to $22,000 per year. It is proposed to enlarge the present station under the hill sufficient to develop power to light the buildings by electricity throughout and drive a system of electric pumps to afford adequate protection against fire. Tenders for the plant will be invited.

An exchange tells of a curious effect of an electrical storm in Chicago on June 16th. The iron structure of the swing bridge over the river at Harrison street was charged. This bridge is electrically connected with the return circuit of an electric railway line, and this connection seemed to "short-circuit" the electricity of the air. George Browne, who was driving near by at the time, urged his horse out upon the bridge in spite of the blue flames that were playing along the iron rods. The animal was hardly upon the structure before the electricity leaped up through the iron calks of its shoes and it went down in a heap, stone dead. Brown leaped from his seat and ran away, and the few pedestrians on the bridge at that time made all haste to get away. A fire and police call brought policemen and a chemical engine to the spot. The police had hard work to keep the crowd back. The draw was finally swung open and the circuit broken. During the storm one young man was struck by lightning and instantly killed. Several others were injured, and there was considerable damage to property.

NOTES.

Vertical belts should be drawn tight enough so that the belt will cling to the lower pulley. Laced belts often break where connected, on account of friction caused by slipping and movement between the lace and belt, which wears away the lace.

One pound of carbon, in burning perfectly, forms 2⅓ pounds of carbonic oxide, and develops 4344 heat units. The carbonic oxide, in burning perfectly, develops 10,210 heat units in forming carbonic acid, making 10210 + 4344 = 14554 heat units, or the same amount of heat units that would be obtained by the complete combustion of one pound of carbon.

To Prevent Breakage of Glass Gauges.—Breakage of glass water-gauges fitted to steam boilers may be prevented in many instances by fusing the edges at the ends, and so finishing them off smoothly and evenly instead of breaking and grinding them. Guards made of toughened glass are also recommended as means of protection to persons standing by in case of gauge-bursting.

Herren L. Holborn and W. Wien have compiled a table, reproduced in the Scientific American, showing the heat-conducting power of the different values. The average value of the different kinds of iron and steel is given. The factor, R, indicates that through a plate of one centimetre thickness, at a difference of temperature of one degree for one square centimetre each, a quantity of heat passes which will increase the temperature of R gramme of water by one degree: Copper, R equals 0.918; iron, R equals 0.156; steel, R equals 0.062 to 0.111; zinc, R equals 0.292; tin, R equals 0.150; lead, R equals 0.079.

We have received, by the kindness of Messrs. John Starr, Son Co., a copy of an illustrated souvenir of the Queen's Diamond Jubilee, entitled "Halifax of To-Day," and published by W. H. Howard. It contains numerous half-tone illustrations of buildings and scenes in Halifax, together with a brief description of same.

ELECTRIC RAILWAY DEPARTMENT.

NEW METHOD OF STRINGING TROLLEY WIRE.

A novel method of stringing trolley wire was recently used by the Sioux City Traction Company on a line lately completed from Covington to South Sioux City. The wire was live when strung, and as it was fastened in place in the hangers it was used to furnish current to the car to carry it to the next span wire.

The spool on the car on which the wire to be strung was wound, was placed in a wooden rack on wooden supports and arranged with a break, which was operated by a man standing just back of the spool. By means of this break it was possible to keep the proper tension on the wire. The car was anchored every 1,000 feet and the work performed as easily as reeling a dead wire on the ground. A half a mile of wire was recently strung in half a day, and the company states that it expects to put up all its own lines hereafter in this way.

TORONTO STREET RAILWAY ASSESSMENT CASE.

JUDGMENT has again been given in favor of the Toronto Street Railway in its appeal against the assessment on rails, wires and poles in Ward 1, Judges McGibbon, Dartnell and McDougall each concurring in the decision.

Judge McGibbon's opinion was set forth as follows:— I still retain the opinion which I expressed in my judgment in the case of the Toronto Railway Company v. the City of Toronto, in 1896, which was a case similar to the one we are now asked to adjudicate upon. Since my said judgment was delivered the judgment of the Supreme Court in the case of the Consumers' Gas Company of Toronto v. Toronto has been delivered, and was referred to on the argument in this case, and it was contended that the judgment in that case concluded us in our judgment in this case. After reading the judgments of the Chief Justice and of Justice Gwynne in the Consumers' Gas Company of Toronto v. the City of Toronto, I am of opinion that this appeal is not determined by that judgment. I find the principle of the judgment of Gwynne, J., is founded on the compulsory power of the Gas Company to acquire and hold land. He says:—

"The sole question is as to the validity of the assessment of the mains and pipes as land and real property. Section 1 of the Act of Incorporation (II. Vict., Chap. 14) conferred upon the company power to purchase, take, and hold lands, tenements and other real property for the purposes of the company, and for the erection and construction and convenient use of the gas works of the company. By section 13 the company are empowered to break, dig up, and trench the street, etc., for the laying down of mains and pipes, etc. This section 13 operates as a legislative grant to the company of the land of the said streets, and below the surface of the said streets as the company finds it necessary to take and hold under section 1, and when the mains and pipes are placed there the land occupied by such mains is land taken and had by the company for the necessary purposes of the company, etc., and is liable to assessment as land."

The Toronto Railway Company have only a street railway privilege, for the purposes of their railway, and have neither the same powers nor property in the street as the Consumers' Gas Company have in the lands occupied or used by them for their gas works and pipes. And I do not think that the judgment in the Supreme Court in the Consumers' Gas Company case governs this appeal. I think the appeal should be allowed, and the assessment struck from the roll.

Judge Dartnell's opinion was summed up in these terms:—This appeal comes up in a slightly different shape from that heretofore disposed of by the Board of the County Judges assigned to take such cases under the assessment acts and amendments thereto. The respondents rely upon the decision of the Supreme Court in the Consumers' Gas Company v. the City of Toronto as affecting the former judgments given herein. So far as the matter of the former appeal is concerned I based my judgment largely upon the construction of the agreement between the company and the city. I express no opinion upon the effect of the recent judgment beyond saying that I cannot see how it affects the ratio decidendi of my former opinion, which I hereby reiterate and affirm.

It is again argued that the exemption from taxation which I conceive has been conferred upon the company by their agreement with the city is illegal and void. The short answer to this is that this agreement has been confirmed by an act of the legislature, and has thus been taken out of the ordinary rules which govern such assessments. The city, should I be wrong, has the option of either proceeding with the pending appeal to the Supreme Court, or by taking an appeal to the Court of Appeal, which they are now enabled to do. I think the assessment should be struck out and the appeal allowed.

Judge McDougall delivered a verbal judgment concurring in the opinions of Judges McGibbon and Dartnell.

SPARKS.

The Ottawa Electric Railway Company will borrow $500,000 to cover the cost of recent improvements.

A report from San Francisco, Cal., states that W. B. Broadbury, a millionaire, has been sentenced to 24 hours' imprisonment on his conviction for the second time for spitting in street cars.

The Sherbrooke Street Railway Company, Sherbrooke, Que., having succeeded in securing water power privileges, have begun the work of construction of power house and surveys for road bed.

Barrister Rowan, of Toronto, was recently granted $1,500 damages for being injured by a trolley car on Spadina avenue. The Toronto Railway Company appealed the case and Judge McMahon has given his decision in favor of the company. The plaintiff will probably appeal.

The British Columbia Electric Railway Company has been registered in British Columbia to take over the business of the Consolidated Railway Company and to construct and operate electric railways, etc., throughout British Columbia. The head office is in England. The capital of the new company is £250,000.

The month of June proved to be the heaviest in the history of the Montreal Street Railway. The earnings amounted to $130,676.77, an increase of $14,248.11 over June, 1896. The average daily earnings during the month were $3,481.11, which is an average daily increase of $215.74. The total increase in earnings for the first nine months of the fiscal year amount to $58,893.82, the figures being $952,120.81.

Professor George Forbes, F. R. S., who played an important part in the "harnessing of Niagara," is expected to arrive in England in a few days from Egypt, where he has been making an extensive tour in many parts of the globe with a view to reporting on the utilization of water power for the generation of electrical energy. He visited New Zealand and Africa, and while in Northern Rhodesia, in order to report on a scheme for using the water power of the Victoria Falls on the Zambesi river, to generate electricity and supply it to the various centres of population throughout Rhodesia. In Egypt, Professor Forbes had a look at the Nile cataracts, and has expressed a highly favorable opinion about utilizing their waste power for generating current.

SPARKS.

Wm. Davidson has started boiler works at Halifax, N. S.

The electric light plant at Huntingdon, Que., was recently put in successful operation.

The council of Kamloops, B. C., has offered $4,000 for the electric light plant in that town.

The Citizens Telephone & Electric Co. are erecting a new office block at Rat Portage, Ont.

The village of Magog, Que., has recently provided the sum of $10,000 for the purchase of an electric light plant.

Mr. Sanford, the absconding treasurer of Barrie, Ont., was also manager of the Barrie Electric Light Company.

The West Kootenay Power & Light Company are about to commence the erection of their power house at Middle Falls, on the Kootenay river.

Mr. Harry Kendrick, of Walkerville, states that he finds the ELECTRICAL NEWS more interesting each issue, and that he could not afford to be without it.

The Kiel canal is lighted over its sixty-two miles by electricity, and is the longest distance in the world lighted continuously in that way. There are 5,000 poles.

Mr. Leo. B. Henderson has been appointed manager of the G. N. W. telegraph office in Ingersoll, Ont., which position was rendered vacant by the death of Mr. W. R. Burke.

The Nelson Electric Light Company, of Nelson, B. C., have placed an order for two additional 1,000-light dynamos. When installed these will give the company capacity to furnish 3,000 incandescent lights of 16-candle power.

The Fraserville Company, of Fraserville, Que., has been incorporated, to manufacture pulp, electrical machinery, etc. Among the promotors are Geo. White Fraser, Toronto; David Cook, Fraserville, and others; capital, $50,000.

The Toronto Suburban Street Railway Company, according to its agreement, were to extend their track through the village of Weston. This has not been done, and a movement was recently commenced by the ratepayers of Weston to withdraw the franchise from the company.

The Brantford Machine and Tool Company has been organized at Brantford, Ont., and will occupy the old Waterous building. The promoters are Messrs. C. H. Waterous, F. Grabb, J. A. Bain, R. Kerr, T. A. Hollinrake, W. H. Shapley, and Lloyd Harris; capital stock, $150,000.

The Stillwell, Pierce & Smith Valve Co., of Dayton, Ohio, who are putting in the hydraulic machinery at the Montmorency Electric Power Co.'s plant near Quebec, Que., are said to have been awarded the largest contract ever given for water wheel and hydraulic machinery. The plant is for the development of the water power at Missina, N. Y., for 75,000 horse power, and will cost one million dollars. The dynamo room is 700 x 65 feet and will contain fifteen dynamos of 5,000 horse power capacity each. The current is to be used in the manufacture of calcium carbide, to produce acetylene gas.

There is said to be a strong probability that a new electric road will be built at Niagara Falls South, Ont., a franchise having been applied for by the Lundy's Lane Electric Railway Company. The chief promoters are Messrs. Henry C. Symmes and R. Paine, of Niagara Falls. It is their purpose to construct a line which will connect with the Niagara Falls Park and River railway in the park and run through several of the village streets up to Lundy's Lane battle ground and observatory.

The Montreal Star gives the following reply to the question: "What year was the electric light discovered and introduced, and in what country?" Humphrey Davy produced electric light with carbon points in 1800. Professor Tyndall lectured at the Royal Institution, London, by the light of Jules Duboscq's electric lamp in 1855. The South Foreland lighthouse was illuminated by electricity in 1858, and the French government ordered eight lighthouses to be so illuminated in April, 1861. In 1878 T. E. Edison, of New York, discovered a method of producing more light at less expense, and from that time the movement towards electric lighting rapidly advanced.

MOONLIGHT SCHEDULE FOR JULY.

Day of Month.	Light.	Extinguish.	No. of Hours.
	H.M.	H.M.	H.M.
1......	P.M. 8.20	A.M. 4.00	7.40
2......	" 8.20	" 4.00	7.40
3......	" 8.20	" 4.00	7.40
4......	" 9.50	" 4.00	6.10
5......	" 10.10	" 4.00	5.50
6......	" 10.30	" 4.00	5.30
7......	" 11.00	" 4.00	5.00
8......	" 11.30	" 4.00	4.30
9......	....	" 4.00 }	3.50
10......	A.M. 12.10	.... }	
11......	" 1.00	" 4.10	3.10
12......	" 1.50	" 4.10	2.20
13......	No light.	No light.	....
14......	No light.	No light.	....
15......	No light.	No light.	....
16......	P.M. 8.00	P.M. 9.40	1.40
17......	" 8.00	" 10.00	2.00
18......	" 8.00	" 10.40	2.40
19......	" 8.00	" 11.00	3.00
20......	" 8.50	" 11.20	3.20
21......	" 7.50	" 11.50	4.00
22......	" 7.50	A.M. 12.20	4.30
23......	" 7.50	" 12.40	4.50
24......	" 7.50	" 1.10	5.20
25......	" 7.50	" 2.00	6.10
26......	" 7.50	" 3.00	7.10
27......	" 7.50	" 4.10	8.20
28......	" 7.50	" 4.10	8.20
29......	" 7.40	" 4.10	8.30
30......	" 7.40	" 4.10	8.30
31......	" 7.40	" 4.10	8.30
		Total,	146.10

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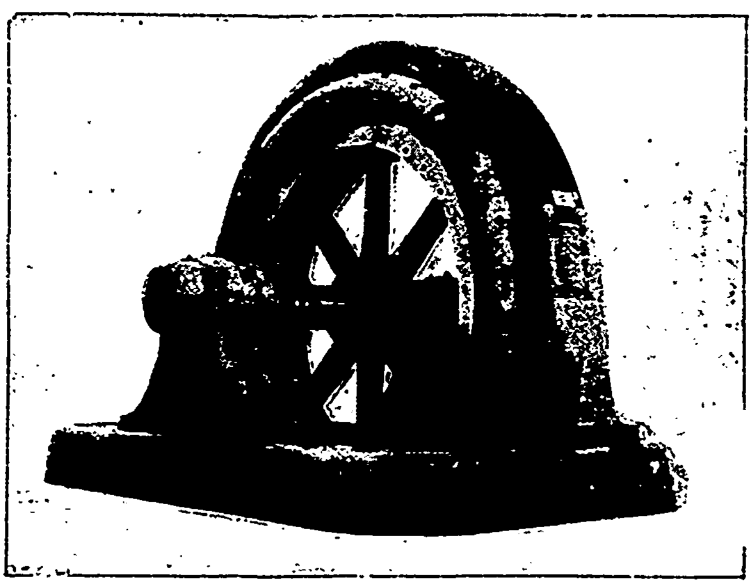


C. G. E. Alternating Generator, Revolving Field Type.

THE WEST KOOTENAY POWER & LIGHT CO., LIMITED,

have just commenced work on the most important power transmission plant so far undertaken in Canada outside of the immediate neighborhood of the city of Montreal. The distance of transmission is thirty miles, the line potential 20,000 volts, and the amount of power to be developed 8,000 horse power. For this important work the three-phase system of the Canadian General Electric Company has been selected and a contract awarded for the initial installation of 2,000 horse-power. The generators will be of the revolving field type, and of 1,000 h.p. capacity each. In type they will be generally similar to the twelve 1,000 h.p. units now being installed for the Lachine Rapids Hydraulic & Land Co.

SPARKS.

R. C. Tremaine is installing an electric light plant at Exeter, Ont.

A by-law to raise $10,000 for electric lighting was carried by the ratepayers of Magog, Que., recently.

The Stratford Gas Company are enlarging their electric light plant by installing a 1000 light generator, of the National Company's latest design.

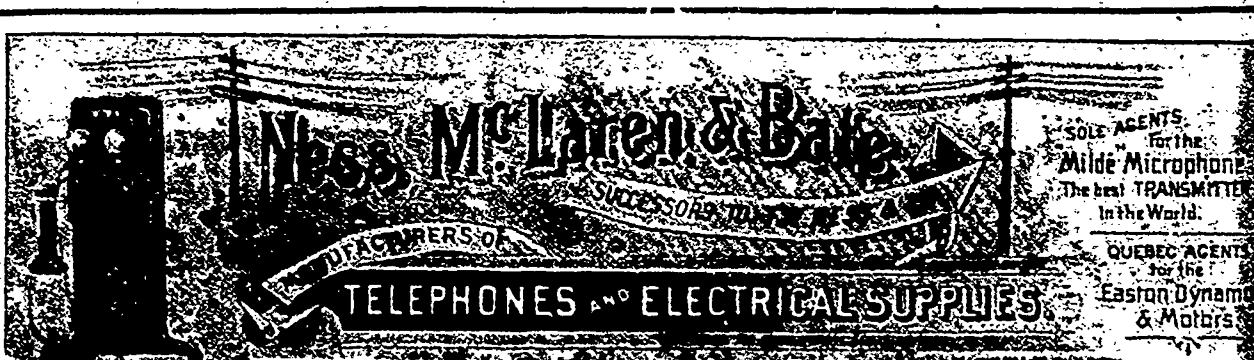
According to Professor Dewar, the best way of ageing a permanent magnet is to dip it several times into liquid air, as it then arrives at a constant condition.

Messrs. Dufton & Sons, woollen mills proprietors of Stratford, are commemorating the jubilee year by refitting their engine room and handsomely decorating their engine, including a very fine royal coat of arms with the motto "Jubilee, 1897."

When a person steps on a wire door mat which has been placed before the entrance of the new city market of Springfield, Mass., the doors are opened by electricity. An electric motor using a 110-volt current furnishes the power for winding up a coil spring and closing the door when the circuit is broken by stepping upon the mat, releasing the spring which opens the door.

The Southern Counties Railway Company was granted incorporation at the session of the Dominion parliament just closed. The company propose to build an electric railway from the north of the county of Chambly, Que., through the counties of Vercheres, Rouville, St. Hyacinthe, Laprairie, St. Johns, Iberville, Missisquoi, Brome, Shefford, Stanstead and Sherbrooke, to a point at or near the city of Sherbrooke. The capital stock of the company is limited to $500,000, and the bonding power per mile has been fixed at $20,000. Mr. A. J. Corneau, of Montreal, is one of the promoters of the road.

Please mention the CANADIAN ELECTRICAL NEWS when corresponding with advertisers.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