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CANADIAN

ELECTRICAL NEWS

AND

STEAM ENGINEERING JOURNAL

OLD SERIES, VOL. XV.—No. 4.
NEW SERIES, VOL. III.—No. 3.

TORONTO AND MONTREAL, CANADA, MARCH, 1893.

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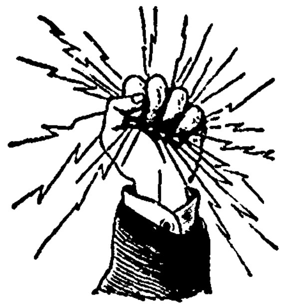

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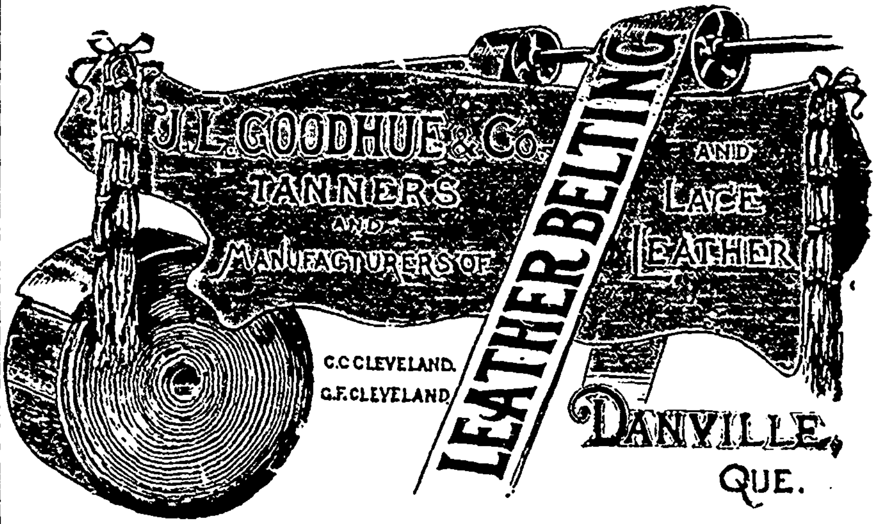

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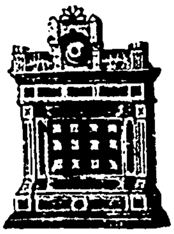

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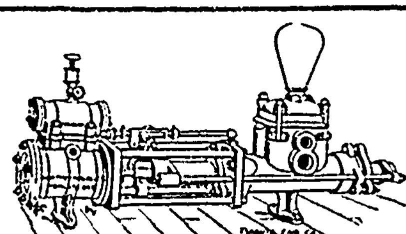

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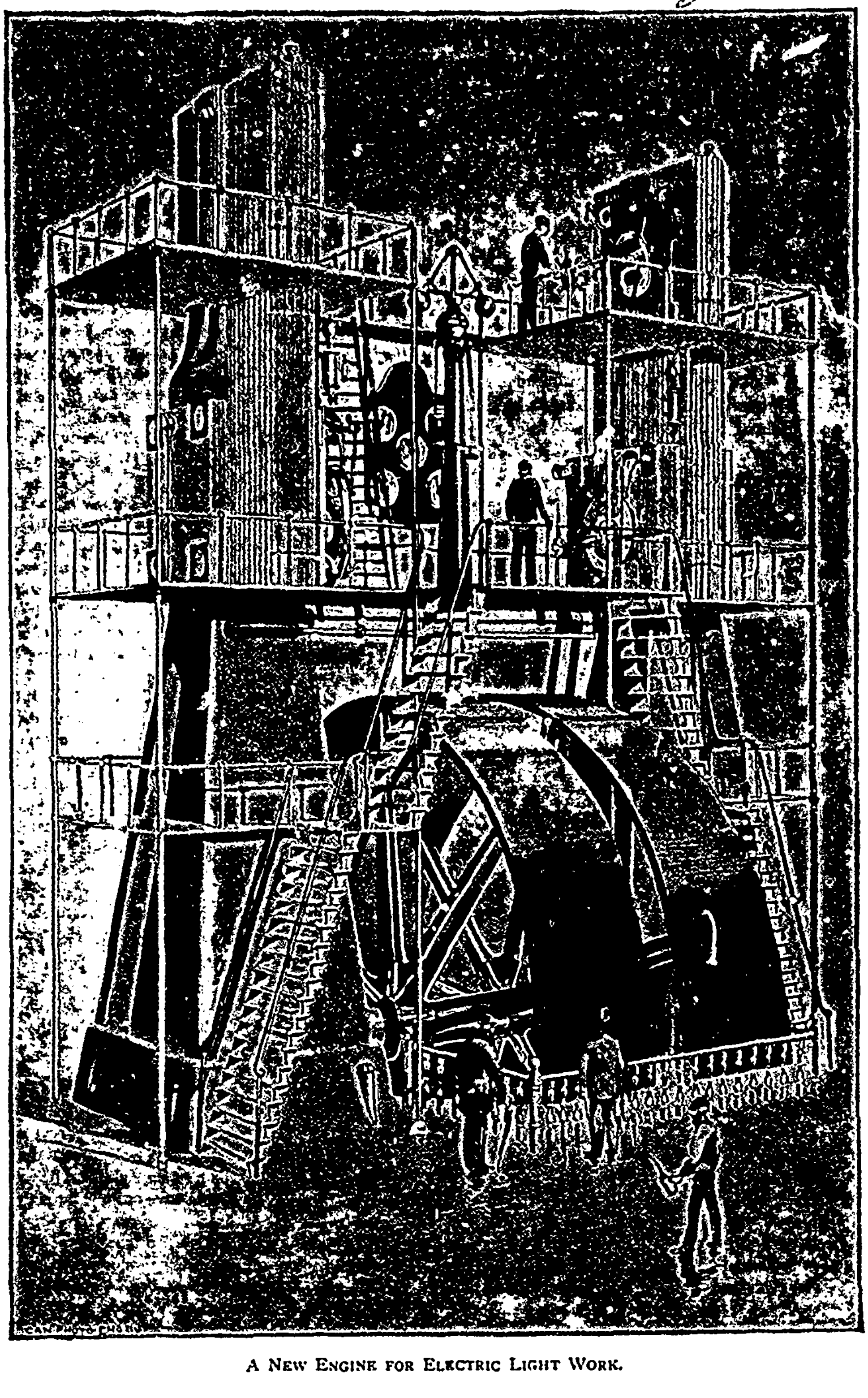
VOL. III. TORONTO AND MONTREAL, CANADA, MARCH, 1893. No. 3.

A NEW ENGINE FOR ELECTRIC LIGHT WORK.

A LARGE engine, of which the accompanying engraving gives an excellent representation, has recently been completed and put in operation at the works of the Toronto Electric Light Co. It may be described as a double tandem upright compound condensing engine, though in reality it is two complete engines combined on a single shaft, and is of the Corliss variety. It may be said to mark a new departure in this country in the development of the steam engine as applied to electric lighting. As the demand for electricity for light and power becomes more general, larger units will be required. In the near future an engine of the power and class here represented will be no larger in proportion to the output of a central station than was the fifty horse power of a few years ago. The engine in question has an easy capacity of over a thousand horse power, runs at 90 revolutions per minute, and uses steam at 120 lbs. per square inch. Steam is supplied by four water tube boilers of 250 h. p. capacity each. Two are of the Heine construction, and two of the Caldwell pattern. There are two independent condensers in connection with the engine, and ample relief valves to enable either engine to exhaust into the atmosphere in the event of trouble with the condensers. The engine is temporarily employed in driving four generators of 250 h. p. each for the Toronto Street Railway, besides arc light machines of the Electric Light Co.



A NEW ENGINE FOR ELECTRIC LIGHT WORK.

If, as it is said, "imitation is the sincerest flattery," the management of the Toronto Electric Light Co. may be congratulated upon the fact that their progressive ideas are appreciated. The Royal Electric Co. of Montreal are erecting a duplicate of these engines, and it is stated that the Toronto Incandescent Company contemplate the introduction of a similar engine, though of a considerably smaller power.

Some forms of arch work undoubtedly obstruct the heat from boilers more than others. When the demand for steam is fairly even and 24-hour fires are kept, a good deal more brick may be judiciously added. To the arch there must be some way of admitting air. It must be remembered that air goes up the chimney the easiest way, that all air above the fire takes from draft through the fire.

ANNUAL DINNER, MONTREAL NO. 1 C. A. S. E.

THE annual dinner of the above Association is always a time of much enjoyment, and as such is looked forward to with pleasant anticipations and reflected back upon with the happiest recollections. The event, which took place this year at the City Hotel on the evening of the 18th inst., was in keeping with its predecessors, if indeed it did not surpass them all.

The chair was occupied with much felicity by the President, Mr. James Robertson. The attendance numbered about 80, and included the following:

Members—Thos. Ryan, Jos. G. Robertson, Geo. Hunt, J. J. Yorke, H. Nuttall, W. McAlpine, Thos. Allsopp, P. Hayes, W. Bill, J. Elliott, H. Thompson, W. Ware, Thos. Biggs, J. Mooney, J. E. Jones, J. Willson, R. Grantham, H. Rolens, H. Weaver, R. Burgess, W. Burgess, W. Galley, J. Arthur, J. Kirwin, A. Nuttall, Ed. Hay, W. Allen, Ed. Orton, J. Robertson, O. E. Greinberg, J. Higgins, W. H. Smith, J. Strickland, J. Badger, J. Black, J. A. Price, F. Carroll, J. Burns, J. Compton, W. D. O'Brien, R. Connolly, H. Tipping, J. McParland, W. Willson, M. Rochfort, H. Latour, J. Oades.

Invited Guests—C. E. Robertson, Hugh Vallance, W. E. Gower, P. H. Couper, John Smilie, Thomas Clarke, Sam. Brickley, Jas. Labresh, Sam. Fisher, T. W. Casey, L. M. Pinolet.

Letters of regret at their inability to be present were read from Major W. H. Laurie, Capt. James Wright, A. E. Edkins, President of the Executive Board, A. M. Wickens, A. J. Darling and Robert Mitchell.

The toast of "Electrical engineering" was first proposed, and responded to by Mr. C. C. Robertson and the representative of the CANADIAN ELECTRICAL NEWS. Mr. Robertson gave a resume of the progress being made in the industrial applications of electricity and also described the magnetic clutches which were being introduced in the electrical engineering laboratories at McGill University instead of friction clutches. He created considerable amusement by his local hits and descriptions.

In response to the toast of "Steam Engineering," Mr. P. H. Couper spoke of the progress being make in steam engineering and alluded to the recent breaking of the shaft of the steamer Umbria and its repair while at sea, which could not have been done a few years ago. Some 20 years ago a pressure of to 20 lbs. of steam was used where to-day many times that pressure was employed. In those days it was thought that any one was able to take charge of an engine, and the engineers were consequently a very different set of men from the engineers of to-day.

Mr. John Smiley also responded to the same toast and gave an interesting account of the engines in use when he was a boy, mentioning, as an example of the crude devices then employed, an atmospheric engine for pumping water which used a steam pressure of but 5 lbs. From the advance that steam engineering had made since then and the strides it was now making, he considered it was only in its infancy.

The next toast was that of the "Manufacturing Interests." Mr. Hugh Vallance in responding said that the Montreal manufacturers were being undersold because labor was dear and their expenses heavy, and advocated the imposition of a tax upon outsiders who sold machinery in Montreal in order to equalize matters. Mr. S. Fisher, who spoke to the same toast, did not agree with the former speaker. He said no Montreal manufacturer should be afraid of outside competition. The best way to hold trade was by excelling in workmanship. He was glad to hear that the Association was to have a course of lectures on steam engineering which would be open to the public.

Mr. W. G. Gower, of the *Engineering News*, spoke for the toast of the "Faculty of Applied Science," describing among other things the fine equipment of the engineering laboratories of this faculty at McGill University and the facilities afforded for instruction, which he said could not be excelled anywhere.

The reply to the next toast, that of "The License Law and Inspection," was the speech of the evening, and teemed with interest to even those outside the profession. The speaker was Mr. O. E. Granberg, Inspector for the Boiler Inspection and Insurance Co., who, after a short prelude, said:

We have general laws to protect life against the carelessness of those who handle drugs and poisons as well as powder and other explosives, and why should we not have a general license law for those who handle steam boilers which may be the most destructive element to life and property when placed in the hands of ignorant and careless men. I know of steam plants being run by men in some parts of the Province, who know no more about the vast power and destructive elements contained in the boilers they neglect and abuse than they do about the North Pole. To illustrate this I will relate a few circumstances that came under my observation. I called at a steam plant where they were putting in a second boiler and an engineer asked me to place the safety valves at 60 lbs., that was all his cylinder would stand. I pointed to the steam gauge on the boiler in use at the time. It stood at 80 lbs. "Oh, yes!" he said, "that is all for one boiler, but I intend using two boilers connected together with 60 lbs. of steam on each; that will give me 120 in my cylinder." And, gentlemen, would you believe it, he appeared to pity my ignorance when I told him I could not see it, and took considerable trouble to enlighten me on the subject. I think that man would take a first class. He knew how to add 60 and 60 together to make 120. I called at another plant and found the condenser stopped. I asked the reason and was told that something was wrong with it—they got too much vacuum. I was surprised at this, as my troubles had always been the other way. I looked around and found they had a pressure gauge on the condenser. I asked about the vacuum gauge, and the engineer told me Mr. Vacuum's gauges were no good, he liked Crosby's best.

When he took charge there was a vacuum gauge on the condenser, and the engine did not work well; so he took it off and put on a Crosby's and found he had forty pounds of vacuum. He knew that was too much; so he stopped the thing altogether, and now his engine was all right. I felt that man was an expert in vacuums, and that it would be useless for me to offer an opinion.

If there were more such associations as this through the country where engineers are banded together for mutual improvement and instruction, and to devise ways and means to secure safety and economy, and get the best results out of their steam plants for their employers, it could not fail to be of great benefit to owners of steam plants and engineers, for there is no class of men to-day who need to understand their work so thoroughly as the engineer, and the man who takes it upon himself to run a steam plant, knowing himself to be unqualified, takes a great responsibility. The engineer holds a responsible position, one that requires his constant watchfulness, a position that requires a knowledge of his work. And yet, notwithstanding all this, I have found men wholly unfitted and unqualified for their work, with boilers just on the point of giving out, with dozens of men, women and children working around them, and that from the pure ignorance of the man in charge. I once found a man just coming out from under his boiler, after having cleaned it, and assuring me that his boiler was all right, and yet, when I went under it, I found it in such a condition that money could not have hired me to get up steam on it—and I have found two men sitting fast asleep under the influence of strong drink, with a roaring fire under the boiler and the water out of sight. I would forever debar such men from taking charge of a steam plant. I feel this Association is doing a good work. It deserves the hearty support and co-operation of steam users and engineers. I am glad to see it growing and its influence for good felt.

Now, as regards inspection, I might say a good deal, but I will not take up your time to-night with more than a few illustrations, and lay before you a few facts to show you the necessity of inspection, and as I have inspected between 500 or 600 boilers during the last year I ought to be in a position to judge of its usefulness. In addition, I have condemned 11 boilers in the Province and had them taken out and replaced by new ones. I might say here that there ought to be a law to have boilers condemned by an inspector, made into scrap iron. All those 11 boilers had been running up to time of inspection. I have stopped 16 boilers for immediate repairs to be done on them, thereby rendering them safe and fit for use. I feel sure that had these boilers not been inspected some of them would have exploded and much suffering followed. I have had boilers cleaned out that had not had the hand hole covers off since they were put to work; some of them five years ago. I have found some boilers so filled up with scale among the tubes that half of them had to be taken out to clean it. I have found plates burnt and cracked, rivets and staves broken, safety valves stuck, old iron hanging on levers to stop valves from leaking when it would take 1,000 lbs. to lift them. I have found gauge glasses and cocks choked up, blow off pipes and feed pipes so corroded and eaten near the boiler that when I touched them with a hammer it went through, and steam gauges 10 and 15 lbs. out. All these facts will show you the necessity of boiler inspection better than any words of mine could do were I to talk to you of boiler inspection all night.

I have found men who knew their work, but did not like to do it, and needed watching; and I have no doubt but that many boilers have been kept in better order for having the inspector coming around from time to time. But I have found men who knew their work and did it well,—men who took a pride in their work, into whose boiler houses it is a pleasure to go—not a leak to be seen about the boilers or piping; safety valves, gauges, glasses and cocks all in perfect order, everything neat and clean inside and out about the boiler. You could see at a glance that an engineer was in charge. You did not have to rub his gauge glass for half an hour in order to see if water was in it. You did not have to wade through a lot of ashes and coal in front of his boiler. He had his ashes properly taken out, and the floor between the coal pile and his boiler is swept off clear. It does an inspector good to see him take the shovel and put coal on his fire. He takes only what he can handle neatly and spreads it evenly over his fire, and he doesn't stop to tell you a long story with his furnace door open. He does not slobber his coal all over the floor, putting about half in the fire, and that all one pile, a quarter on the floor and a quarter in the ash pit to be wasted.

You may look at his ashes and you find ashes only. Go into his engine room and you do not need creepers on to keep you from slipping on the dirty, oily floor. You do not find a lot of old pipe fittings, old steam and water pipes, monkey wrenches, pipe tongs, hammers, oil cans, old boots and rubbers, paint cans and brushes, all scattered about the engine room floor, engine pounding and oil flying about, and the place half full of steam, No! You find the place clean, the floors washed, the engine running smoothly—all is clean and neat about the place and himself. I say I have found men who knew their work and did it well. Let it be said to your honor and credit that I have found the most of that class of men in your Association.

The next toast was that of the "Brotherhood of Locomotive Engineers," with which were coupled the names of Messrs. Thomas Clark, Samuel Brickley and Labrecque. Mr. Clark responded, and said he entirely endorsed the remarks of the previous speaker, considering it to be against the interest of any employer to employ an engineer who did not have an Association certificate. He said the Locomotive Brotherhood, which was organized in 1863 and was now in such a prosperous condition, did not start with such prospects of success as had the Stationary Engineers' Association. He referred to the insurance department of his Society, in which every member was obliged to take out one, two or three policies of $1,500 each, and which was of the greatest benefit to them. Since organization, the Brotherhood had paid out for death claims $3,500,000, and over $1,250,000 for assistance. In conclusion, he explained the manner in which the Brotherhood was conducted and the principles which guided them in dealing with their employers. He also alluded to the reports that had recently circulated in the press that the railway employees were preparing for a grand strike during the World's Fair. He could not answer for the other organizations, but he would answer that there will not be an unprovoked strike during the World's Fair on the part of the engineers. They would always do their duty, and the public when hearing such reports should remember the record of the Brotherhood during the past twenty-eight years. This statement was greeted with cheers by all present.

For the N. A. S. E. and C. A. S. E., Messrs. Thomas Ryan and George Hunt responded. Mr. Ryan said that the present dinner was the most successful one they had ever had, and that employers were beginning to find out that it was in their interests to employ only Association men, as the Association endeavored to educate the engineers up to a high standard so that its members would be able to render the best possible service to their employers. The question of wages never came up at their meetings, which were held solely for the purpose of mutual improvement.

Mr. Hunt, after referring to the flourishing condition of the Association and its constantly increasing membership, spoke of the question which had been raised at the Hamilton meeting as to what was the best engine for electric railways. He strongly condemned the usual practice of consulting some big theoretical engineer on such matters, as this had frequently led to the selection of a type of engine which was utterly unsuited for the purpose. The best course for those interested was to consult some good practical engineer.

Then came the toast of "The Press," which was responded to by the *Gazette* representative. During the evening songs were given by George Hunt, W. G. Gower and H. J. Weaver.

QUESTIONS AND ANSWERS.

"A. Z." writes as follows: Kindly answer the following questions in your March number:

1. Will a current indicator work equally as well on an arc circuit if placed on the outgoing or incoming wires? If not, why?

2. In running two arc dynamos in series, would they work equally as well if they were placed at the opposite ends of the circuits. Of course, this is merely a suppositious case.

3. Can you tell me why my brushes cut more under a light load than under the ordinary load. We use water power here, and the dynamos run slower when there are fewer lamps on. Is this the reason?

ANSWER.—It will make no difference where an ampere meter or current indicator is placed. The current is the same in all parts of the circuit. It should be kept out of the influence of the field magnets of a dynamo however if it has permanent magnets in its construction.

2. It would make no difference in the working of two dynamos in series if they were in different parts of a circuit. As a matter of fact they are sometimes so operated miles away from each other.

3. The cause of the sparking under light load may be for various reasons. It is probable that in cutting down the number of lights the balance of the machine is disturbed and the brushes are not at the correct neutral point of the field.

SHAFT SPEED NEEDED.

THIS table gives the least shaft speed in turns per minute for steel shafts (not given sudden changes of load or speed and not bent) of different diameters, for various horse power. It is built from the rule multiplying the desired horse power by 92 for steel and dividing the product by the cube of the diameter in inches. Thus a steel shaft 3 inches actual diameter, to give 100 horse power, should turn at least $100 \times 92 \div 27 = 340.7$ times a minute.

Shaft di'm. inchs	Cube of diameter inches	HORSE POWERS.								
		10 R P M	20 R P M	30 R P M	49 R P M	50 R P M	100 R P M	200 R P M	300 R P M	400 R P M
1	1	920	1840	2760	3680	4600	9200			
1.25	1.953	736	1472	2208	2944	3680	7360			
1.5	2.375	614	1227	1840	2454	3067	6134			
1.75	5.359	526	1051	1577	2103	2629	5257			
2.	8	460	929	1380	1840	2300	4600	9200		
2.25	11.39	499	818	1227	1636	2044	4089	8177		
2.5	15.625	368	636	1104	1472	1840	3680	7360		
2.75	30.796	334	669	1004	1338	6273	3345	6691		
3.	27	307	614	920	1227	1533	3067	6133	9200	
3.5	12.875	263	526	789	1051	1314	2628	5257	7886	
4.	64	230	460	690	920	1150	2300	4600	6900	9200
4.5	94.125	204	409	613	818	1022	2044	4089	6133	8177
5.	125	184	368	552	736	920	1840	3680	5520	7360
6.	216	153	307	460	613	767	1533	3067	4600	6133

—*Power and Transmission.*

STRENGTH OF SHAFTING.

IT is generally pretty well known that a shaft will transmit power in proportion to its running velocity, and, therefore, the faster a shaft runs the lighter it should be within reasonable limit. The use of extremely heavy shafting is not advisable under any circumstances unless actually needed to perform the work required. Some imagine, says the *Mechanical News*, that a large shaft, affording a very strong margin of safety, is the most economical to use; that, however, cannot be considered a ogical and tenable mechanical position, unless tempered with sound judgment and much wisdom, sufficient of both to select properly. That there should be an ample margin of strength no one will attempt to deny, but shafting multiplies in strength so rapidly as sizes increase, that the unenlightened are apt to make the selections much too large when aiming at only ample strength margin. To show how easily uninformed mechanics may make mistakes of that kind, it is only necessary to say that a three-inch shaft has nearly three and one-half times the transmitting strength of a two-inch shaft. None unaware of the fact would ever guess at that difference and may fall into the error of selecting a three-inch shaft to safely do the work of a two-inch. To more forcibly illustrate the difference, it can be stated that a two-inch shaft, properly sustained with bearings at reasonable intervals, will safely transmit 20-horse power at 100 revolutions per minute and at the same time resent the transverse strain due to weight of pulleys and the pull of belts necessary for transmitting that much power. Under like circumstances and equally proportionate conditions, a three-inch shaft will just as safely transmit 68-horse power at 100 revolutions per minute. Shafting should never be so large as to make it absolutey rigid; on the contrary, it should be to a fair degree elastic, with an ability to give and take between the power and the work. When too rigid, unless away above all requirements in size and strength, the liability to break is increased, especially if the work is of an abrupt and severe character. Long lines of shafting, having the power at one end and the work at the other, should be graduated in size; the work end being of a size required to safely do the work and the power end larger in proportion to the length of the shaft or the distance between power and work. If such shafts be of the same size the entire length, and that a fair working size only, there will be too much elasticity in the aggregate, which will tend to gradually weaken, distort, and in the end destroy the usefulness of the shaft.

PROBABILITIES AS TO THE SUCCESS OF DISTRIBUTION OF POWER AT CONSIDERABLE DISTANCES BY HIGH TENSION CURRENTS OF ELECTRICITY.*

The subject of the transmission of power forms the fundamental problem of mechanical engineering, while the conversion of energy from one form to another is, to some extent, also considered under this branch of Applied Science. Electrical engineering extends, perhaps, over a somewhat wider field, concerning itself as it does with the three principal manifestations of energy, viz., light, heat and power.

We have at command an unlimited supply of energy in a great variety of forms, chief of which are the energy stored up as potential in coal, wood and other fuels and the forces of nature especially wind and water.

By means of combustion we have, so far, drawn our supply of heat, and through it also light, directly from the energy stored in fuels. The process, under proper conditions, is a fairly efficient one, too, at any rate it is as yet by far the cheapest method and almost the only one we have of producing heat, and it probably will remain so for a long time. As regards light, though the electric light is in every respect an undoubted success, we all know that it costs more than the light our grandfathers used, or even than gas. If this was a gas convention, I might dilate on the fact that in the town of Berlin, where Edison 16 c. p. lights are furnished at 10 cents per week, and gas at $2.00 net, a number of consumers have ordered out their incandescents and gone back to gas.

At the present day our greatest sources of power are our forests and coal fields, and though we pride ourselves that in this century of progress—especially so in the applied sciences—machinery in general has been brought to a high state of perfection, yet we are forced to admit that the steam engine method of transforming and transmitting energy is a very inefficient one. By it we have not been able to utilize more than 10% to 12% of the energy stored in coal, and to transmit power over any considerable distance we are obliged to transport our fuel to the point of application. The system involves a double transformation to bring it from the form of potential energy to that of power. A natural water power on the other hand we need only transmit, though this may involve a transformation. Beringer estimates the cost of water power as 1-5 to 1-10 that of steam power. If this estimate is correct we should be able to utilize much of the immense water power now going to waste and bring it to our manufacturing centers, there to furnish light or power in any desired quantity.

The problem of transmission involves two distinct cases.

(1) Distribution in small quantities over limited areas, as e. g. central station distribution.

(2) Transmission of energy in large units over considerable distance, as where a large power supply is available, but at an otherwise inaccessible place. Under this head again, two cases may arise—where all the energy is to be delivered at one place, and where considerable quantities are to be delivered at each of several places.

Of the purely mechanical methods of transmitting power there is a great variety, most of which under proper conditions and over limited distances are quite efficient. Of these, the method of belts and shafts is no doubt the best for very short distances, such as transmitting from a prime mover to a piece of machinery. Long lines of shafting, however, present some difficulty both in construction and operation, and where it is required to turn corners, both belts and shafts are cumbersome and liable to get out of order.

For greater distances wire rope is often used with good results, the best example of which is the case of cable railways. According to Beringer's table, the efficiency of this method drops from 93% at 500 meters (about ⅓ of a mile) to 13% at 20,000 meters (12.4 miles). At a recent cable railway test at which the writer assisted, we found that altogether the road was operated quite economically. Where traffic is heavy, the system is undoubtedly a good one.

Transmission by compressed air distributed through pipes is available for greater distances. One of its hindrances lies in the fact that during expansion the air absorbs so much heat that the expansion machinery is often cooled so much as to interfere with its proper working, though this can be partly overcome by heating the air before it enters the machinery at the receiving end. The efficiency of such a system varies from 55% at 500 meters to 40% at 20,000 meters, and can be increased about 20% if the air be heated. Like wire rope, its first cost is high, and its applicability therefore limited. Its principal use is in mining, though I understand a plant has been installed in Toledo, Ohio, for street car work, using a pressure of about 400 lbs.

Transmission by steam distributed through pipes and by hydraulic means may also be mentioned as among the purely mechanical methods, but their application is very limited, where gas is cheap the gas engine can be used to good advantage, in fact, it is extensively used for small power even where the gas supplied is manufactured.

The problem of distribution over a limited area is in general best solved by electrical methods, and of these the most successful is that of distribution by direct current at constant pressure. The dynamos and motors of this class, shunt and compound wound, usually have an efficiency of over 90% (i. e. the larger sizes), and the loss on the line can easily be made quite small, so that we may reasonably expect to have over 75% of the mechanical horse power delivered to the dynamo for actual use at the motor pulley. Moreover, the cost of such a plant is not nearly so high as with any of the purely mechanical means, and a pressure can be used which is perfectly safe. The great number of central stations now supplying power and the many electric railways are the best evidence of the success of this method. Series wound apparatus can also be used, but since the torque on the armature varies with the strength of the field and current supplied, while speed varies with pressure, a governor will be required where a number of motors with varying loads are to be supplied from the same mains.

Let us consider the requirements of the problem of long distance transmission. Any system, to be successful, must, of course, deliver power at the receiving end cheaper than it can there be produced. This practically limits the case of long distance work to cheap sources and large units. Its principal factors then are:

1. Primary cost.
2. Working expense.
3. Safety.

In electrical transmission we have at present three different methods, viz.

1. By means of direct currents either at constant potential or constant current.

2. By means of simple alternating currents.

3. By means of the three phase alternating so-called rotary current, which received its first great trial at the late Frankfort Electrical Exhibition and which has since then been the subject of so much criticism, both favorable and adverse.

In any case, unless we can thereby effect a corresponding reduction in the working expense, coupled with a fair degree of safety, the cost of our plant must be reasonably low—this means that the machinery must be as simple as possible; further, it should consist of the fewest possible number of interdependent parts so as to reduce the liability of a break-down to a minimum, and it should not be liable to get out of order.

In all these respects, as in many others, the direct current system so far has the advantage, and we are inclined to think that very many, if not most of the cases arising in ordinary practice, can be thus dealt with by this method. True, we cannot carry a pressure anything like obtained by means of simple alternating or tri-phase currents, for, since we have no method of transforming continuous currents except by moving machinery, we must generate at the voltage used on the line. The maximum potential difference we can safely use on an armature is probably 2,000 to 3,000 volts, though some engineers claim it can be carried as high as 5,000 volts. For such high pressures, the commutator would require to have a great number of segments to prevent the current leaping across from one to another. The armature would require an equal number of coils and the whole thing would be difficult to construct. Still, 75 Kilowatt shunt or compound wound machines carrying a potential difference of 2,000 volts, would probably work quite well; in fact, I believe there are some in use having even a larger output at this voltage. Take e. g., a case where a good steady water supply of 100 to 150 horse-power is available at a distance of say 5 miles, and where we can afford to allow a loss of 20% on the line. Using a 100 horse-power 2000 volt generator, the required diameter of the line on a complete metallic circuit would be only slightly over two-tenths of an inch, about No. 4 B. & S. gauge. With an efficiency of 90% in the machines, we should still have 63 horse-power available at the motor pulley. Taking the cost of machinery as $30.00 per horse-power, copper as 20 cents per pound, poles at $4.50 per set, and allowing 35 poles per mile, the first cost of our plant would sum up to $127.00 per horse power delivered. The question of what loss to allow on the line is a very important and sometimes difficult one, since primary cost and working expense here vary inversely. Sir William Thomson, now Lord Kelvin, gives the rule that for the most economical operation, the cost of the energy wasted on the line should equal the annual interest on the amount invested in that part of the line which may be considered as being proportional to the weight of the conducting material used.

For distances where a high pressure is required, it has been proposed to use a number of dynamos coupled in series and an equal number of motors also in series at the receiving end. We could thus supply almost any desired pressure. The scheme has, we believe, been tried in France, where one of the difficulties encountered was that in case of a break in the circuit the machines were invariably burnt out. A Swiss firm have submitted plans on this system for carrying 800 horse-power from Niagara Falls to Chicago, they propose to use 10 machines of 100 horse-power, and 3,000 volts, each making a total initial pressure of 30,000 volts, and allow a loss of 24.5% on the line. Counting on an efficiency of 90% in the machines, the plant would have a total efficiency of 60%. The motors at the receiving end would drive dynamos which in turn would supply current at any desired potential difference. Taking the distance as 500 miles, we find that to get the results above stated, we should require a wire having a diameter of about .37 inch (about No. 00 B. & S. gauge) for a complete metallic circuit. The total weight of copper would thus be something over 1063 tons. All continuous current systems have the advantage that a ground return can be used, which, for the same line efficiency reduces the amount of copper to ¼ that required for a two wire circuit; this was proposed for the Niagara Falls-Chicago transmission.

Alternating currents furnish a ready solution of many of the difficulties in the problem of power transmission, but as yet we are in the position of the man of whom the German proverb says, "he had the soup but not a spoon." We are not hampered by any commutator difficulty, neither are we obliged to handle currents of such high voltage as to be dangerous, either at the generating or receiving station. We can generate at low voltage, transform by means of stationary apparatus, which requires no further attention to a high voltage, thus to be transmitted over the line and again reduced to any desired potential difference at the other end. The method involves more interdependent parts, and the first cost of such a plant is generally somewhat higher than where continuous currents are used. Further, for alternating currents, the practical resistance of a wire is not the same as for continuous currents, since periodicity and self-induction must now also be considered. It is no longer a constant quantity whatever the current, and to do the same work we may and often do require a wire of greater cross-section. Again, the E. M. F. now varies periodically between zero and a certain maximum; the effective E. M. F. is therefore only a mean, and we must insulate against a greater voltage than that indicated.

Whether it be advisable to use step-up and step-down transformers will depend on distance and the line loss we can allow. In every case the cost of the transformers must be balanced against the additional cost of copper which they save.

The ordinary motor for simple alternating currents has the great drawback that it will not start itself. When running it must be kept in perfect synchronism with the generator supplying it, the result of which is that when overloaded it comes to a dead halt, sometimes with disastrous results. The only way it can be used is therefore to start it by some independent means and bring it up to the required speed before we turn on the current; the load can only be applied after this has been done. In cases where only one motor is to be supplied from the line, and the load is a constant one, the system can be used to advantage. A notable example, and the only one of which we know, is the mining plant at Telluride, Col., installed by the Westinghouse Company. A potential difference of 3,000 volts is used and 120 H. P. are transmitted 2½ miles at an efficiency of 75%. This plant we believe, is doing its work well, its total primary cost is given at $100.00 per H.P. delivered.

Mr. Tesla, some years ago brought out a new form of alternate current motor which has, however, as yet, not been put to practical use. The principle involved is quite simple. Take e.g. a four pole machine and excite the field by means of two separate alternating currents, opposite poles being wound on the same circuit. If we give to these currents a phase difference of 90 degrees, they will produce a resultant magnetic field which will rotate with the same periodicity as that of the exciting currents. The armature needs no commutator; its coils are all closed on themselves and the currents induced in them are of such a direction as to cause it to revolve with the resultant field. Mr. Stanly has lately devised a motor on which he uses a condenser to neutralize the effects of self-induction, and also a method by which he claims the Tesla motor can be used on any simple alternate current circuit. Still another new form is that of Ganz. It seems therefore altogether probable that we shall soon have motors which can be supplied from any simple alternate current circuit and which will do the work required of them as well as continuous current motors do now; this will certainly be a very great step in advance.

As to the merits of the tri-phase alternating current, it possesses the same advantages as the simple alternating current, in that it can be changed to any desired voltage by step up and step-down transformers. The system received its first great trial at the Frankfort Electrical Exhibition in the summer of 1891, when the energy of a waterfall was transmitted from Lauffen to Frankfort, a distance of 108 miles. This experiment has been so

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* Paper read by Mr. E. Carl Breithaupt at the second convention of the Canadian Electrical Association, January 25th and 26th, 1893.

carefully described and so much discussed in all the engineering papers that I need not take up time in further explanation. The underlying principle is the same as that of the Tesla motor. The armature of the dynamo is so commutated as to deliver three separate alternating currents differing in phase by 120 degrees, which currents are sent out over three separate wires. For a suitable motor we have the choice of two types, viz.: a reverse tri-phase dynamo and a machine like that of Mr. Tesla having its armature coils short circuited on themselves, the phase difference being 120 degrees there will be in this case three pole pieces. The further advantage is claimed for this system that it causes not only a definite rotation of the resultant field but also a definite direction of rotation, but we think both these points can be satisfactorily attained by means of the two phase current.

The first named type of tri-phase motors, like the synchronous, simple alternating motor, must harmonize in phase with the generator, it is, therefore, not necessarily self-starting, though it will start with the generator. Its fields must be excited by continuous currents. The second type will start itself, even under heavy load, and of course requires no separate field excitation, its speed is also fairly constant under variations of load. The *Electrical World* of last week contains a very interesting table of efficiency and other data for small machines of this class, compiled by the Oerlikon Company of Switzerland. With this motor the tri-phase system should be quite as commercial for central station distribution as the continuous current. Moreover, by means of specially designed motor dynamos, it can be transformed into continuous currents of any desired voltage. We could thus transform energy from a large and otherwise inaccessible source over a considerable distance and supply current either alternating or continuous at any desired potentential difference and for any desired purpose.

At the Frankfort-Lauflen plant, current was generated at a potential of 50 volts and strength of 1400 amperes. An average pressure of 10,000 volts was carried on the line, for which a copper wire 4 mm. in diameter was used —about No. 6 B. & S. gauge. The capacity of the generating plant was 300 H.P.; transmitting 80 H.P., an efficiency of 72% was claimed. The total cost per H.P. delivered was stated to be about $282.00 of which $236.00 was for the line, leaving $46.00 per H.P. for the machinery. The machinery there used was that designed for the Lauffen-Heilbronn plant, which is now in successful operation.

Summing up then: Of the different systems now in use for the transmission of energy, in cases of any considerable distance the electrical methods make undoubtedly a better showing in point of efficiency than any of the purely mechanical methods, and they have also much the advantage in first cost. Relatively, therefore, the probabilities of success are in favor of electrical methods. Which of these is the best one, will depend on circumstances and must be decided separately for each case; it is all a matter of dollars and cents. So soon as the distance exceeds a few miles the low tension current of course drops out of consideration. For moderate distances, not oversix to eight miles, we think continuous current apparatus will generally be found the most suitable. If we want to supply a number of large motors, each with varying load, the problem will be difficult, but it will be so in any case.

For long distances, the tri-phase current is, we think, at present the most suitable, and there are many instances where large water powers now going to waste could thus be utilized. Whether we shall ever be able to transmit power over such great distances as from Niagara Falls to Chicago or New York and deliver it cheaper than it can be there produced is, to say the least, very doubtful. There is no occasion for it, for, granted that it could be done, we could certainly get nearer to the source of supply, and thus effect a still greater saving.

DISCUSSION.

The President: I notice that in your paper you deal with distances of from two to five miles, and then very much larger distances, such as from New York to Niagara Falls, and from Niagara Falls to Toronto. I would like to ask you to give your opinion whether the probabilities are in favor of power being transmitted from Niagara Falls to Buffalo as cheaply as it could be generated with coal purchased thereabouts?

Mr. Breithaupt: I certainly think it can be done, Mr. President. There has been so much said about it that I purposely avoided that in my paper. I expect that within a year or two power can be delivered in Buffalo cheaper than it can be produced there by ordinary steam engines in small quantities. When you get a very large steam plant, such as a thousand horse power engine, with all the best improvements, such as triple expansion cylinders and so on, power there is comparatively cheap too, especially in Buffalo, where coal is cheap. In that case perhaps the difference between the two systems would not be great. But for ordinary machinery, in small quantities, from one or five to fifty horsepower, or anything like that, it seems to me that the Buffalo plant should be able to do business. Of course, I do not want to express a positive view, because it must be determined by the circumstances of the case.

The President. Of course my question was rather sectional. No doubt, many people believe it can be done commercially, although the experiment may not be so far advanced. At the same time, the plant that is in course of construction, and the immense force of Niagara Falls can be utilized to drive manufactories on the spot. If it is determined in the near future that the electrical business is not going to pan out, it will be very easy to drop that part of the scheme, and utilize the power of that canal on the spot, as at present they are not committed to any particular system.

Mr. Wickens: If it be possible to produce this current at the Falls and carry it to Buffalo for as little money as it can be made in Buffalo, after the line is carried to the city and you begin to make the distribution all over the city, up into this little factory, and down into that little factory, you have got to make reductions, as I understand, in this scheme. Will not there be a loss there? If this power was conducted to Buffalo, to a large station, and utilized there, then, of course, losses would occur when the current was re-made, as it were, and being distributed in that city. If the scheme will drive a large power station in Buffalo as cheaply as a large station can be driven by steam power, then the distribution from the dynamo in that station will be the same as to-day, and we know what it is. But if the scheme will not do that, will only reach places that are driven with small powers, why, we know that the cost of driving small steam power is much greater than large, and the distribution has got to go to these small ones; it is a question whether one end won't counterbalance the other, and go into the same hole it came out of almost.

Mr. Breithaupt. The only question is whether you can deliver from the dynamo at Buffalo cheaper than it is supplied by steam power there. If that transmission becomes an accomplished fact, the loss would be very small. That point does not come into the question, because if you can bring it there, then you can start a distribution plant from there just as cheap as from the other. It is a matter of electrical engineering. You can measure what the loss is in the first dynamo, and in the line, and can get at exactly what percentage of power will be delivered at the motor, and from that you can easily figure whether it will pay better than the other.

The President: I understand that soft coal, for steam purposes, can be purchased in Buffalo at from $1.00 to $1.60 per ton. If that is the case, the probabilities are that the electric company is not in it. You can figure up, of course, to a dot what it would cost per horse power, taking an ordinary well constructed high pressure engine. The amount is four pounds per horse power per hour, and the total expenditure for fuel is not very great. If you begin right at the water at Niagara Falls, you have the cost of construction of these large hydraulic works, they must pay interest on the cost of construction, and then, you must remember, there will be interest on the cost not only of the water that goes through the tunnel, but there is the water that will go through the stock, you see, that has to be figured. There is no doubt that concern will be capitalized at a much higher amount than the actual outlay. That has to be considered. Your power is going to cost you a certain amount at the Falls, and then you have a hydraulic plant to maintain, turbine wheels and so on, and machinery won't run for nothing. Then there are generators and dynamos, whatever is going to be used, they will require looking after. A large number of the members here know what it means to maintain a dynamo. Then there are the transformers, from low to high tension, the high tension transformer will of course be a destructive element. It is all very well to say that by using the alternating current it will do the work itself; those of you who have transformers will know that they, too, are ticklish cattle to handle, especially fifteen or twenty five thousand volts. Then you have the line, interest on that outlay, construction, and cost of right of way, and all those matters to be taken into consideration, and a distributing place at Buffalo, and transformers again. So, by the time you would get it to the consumer, it is an open question whether it would pay or not.

Mr. Dwight: Mr. President, as I suppose these meetings will close to-day, I wish to say this is the first opportunity I have had of attending your meetings, and I wish to tell you how much I have been interested in the papers that have been read to-day. I have tried to keep track of almost everything in connection with electrical matters, and the consequence is that I really know very little about the thing, as the field is so large that one who tries to keep track of it all can only do so in a very superficial manner. I do not know very much about any special subject, but I try to know a little about everything, and the papers I have heard appear to me to be wonderfully suggestive. That of Mr. R. G. Black, read this morning, I think all will agree, was exceedingly interesting. One idea suggested, that there is a time when it pays to smash an electric lamp, is something new. I think we have always thought rather more of how long we could make it last. Then Prof. Rosebrugh's paper, and the last one by Mr. Breithaupt, I am sure we shall all be glad to have the opportunity of reading when printed. I think every member of the Association is deeply indebted to the gentlemen who have read those papers to us, which they have evidently taken so much pains to prepare. I have much pleasure in moving a vote of thanks to Mr. Breithaupt, for the paper he has just read.

The motion was seconded by Mr. McFarlane and carried.

TRADE NOTES.

The London Electrical Works Co., under the same management as the London Machine Tool Co., has recently commenced the manufacture of electric motors at London, Ont.

The London Machine Tool Company have recently constructed a mammoth lathe weighing about 25 tons, for Alex. Fleck, of Ottawa. It will be used in the construction of heavy machinery, such as engine cylinders, which can be turned ten feet in diameter or length. It is said that no lathe of such dimensions was ever before built in Canada.

The Ottawa Electric Light Co. have recently moved into their new station. They have materially increased their plant, and have now one of the finest arc stations in the Dominion. A feature of the plant is the use entirely of rope drives for main transmissions, erected and supplied by the Dodge Wood Split Pulley Co., of Toronto, under their patent system. There are two main drives from the water wheel shafts to main driving shafts, having a capacity of 300 h. p. each. All iron grooved pulleys are used, and the silent, positive and steady manner in which the power is transmitted, is a great satisfaction to all concerned, as well as a matter of much interest to power users in general. Engineers and mechanical superintendents who are still skeptical on the question of rope driving, would find much to interest them around Ottawa, Hull and vicinity.

HAMILTON C. A. S. E.

HAMILTON, ONT., Feb. 16, 1893.

Editor ELECTRICAL NEWS:

SIR,—At a recent regular meeting of the above association, Mr. D. Thomson, General Manager of the Hamilton Electric Light and Power Company, gave a talk on electricity. Mr. Thomson had double and single arc lamps, incandescent light volt meters, ampere meters, transformers, a small dynamo and motor all running in our hall, so that on our arrival it looked like a testing room.

Mr. Thomson, in introducing the subject, said he didn't propose to go into any extended or profound explanation of the many uses of electricity, but simply to show some of the apparatus in use for making practical application of electricity for commercial purposes. He described the method of operating incandescent light, the various methods of wiring, etc. He explained the street railway construction and operation, the nature and uses of bonds, grounds and feeders. He also clearly described the electric motor, illustrating his remarks by illustrations on the black-board, and with the motor in operation on the platform the dynamo and generator were likewise explained, as well as the different currents, how currents are made to alternate and the frequency of alternation. In conclusion he referred to one of the latest means of employing the electric current commercially, viz., for heating purposes, and described how the current was passed into a coil and how heat was produced by the resistance offered to its passage.

Mr. Thomson cooked griddle cakes by the aid of a little electric griddle and distributed them among the audience. This is the first cooking done by electricity in Hamilton.

In closing the lecturer said that he had not a particle of doubt that many of his hearers would live to see the day when coal as a means of producing heat in houses would be entirely replaced by electricity.

At the close a cordial vote of thanks was passed to Mr. Thomson for his instructive address, after which Mr. Gough, of Toronto, Mr. Black, Manager of the G. N. W. Telegraph Co., and Ald. Dewey also highly complimented him.

R. D.

LETTER OF THANKS.

Editor ELECTRICAL NEWS.

SIR,—I wish through the columns of the NEWS to convey my sincere thanks to the members of Ottawa No. 7, C. A. S. E., and especially to Bros. J. Thompson, R. Robert, A. Gaul, J. Latour, J. Cowan and——Corbett, for the very kind manner in which I was treated by them on my recent visit to Ottawa for the purpose of organizing No. 7 Association. I was through their kindness enabled to visit all the government buildings including the Geological Department, which was most interesting; also the Patent Department, in the model room of which one could easily spend a day, looking over the thousands of models.

All the electric light and street railway power stations were visited, and my stay was made so thoroughly enjoyable that I was loth to leave when the time came. For genuine good-heartedness and sociability it would be a hard matter to beat the boys of Ottawa.

I remain, yours truly,

ALBERT E. EDKINS,
President Executive, C. A. S. E.

A GUELPH STEAM PLANT.

Editor ELECTRICAL NEWS

SIR,- I visited Guelph a short time since, and among the steam plants in that busy little city are several which reflect credit on the engineers in charge, and should be a source of pride to the owners. One in particular, is the plant which supplies the motive power in Messrs. Bell & Co.'s organ and piano factory.

The plant consists of 3 horizontal tubular boilers as follows: One 16' x 60", and two 14' x 60", which are fed with plunger pumps and two exhaust injectors. The engine is an 18"x42" Wheelock (non condensing), which is developing 150 H.P. according to cards taken by a Thompson improved indicator, which is always connected on the engine, cards being taken every week. The lighting plant consists of two 325 light 16 c.p. 90 volt Brush incandescent dynamos and one 75 light 16 c.p. 90 volt Kay dynamo, the latter being used for day service and the former for night. The building is heated throughout by exhaust steam. The system was constructed by Mr. R. Bell, the engineer in charge, who is a member of Guelph No. 6, C.A.S.E. Mr. Bell has in operation a very ingenious little electrical apparatus for stopping his engine by any employees in any part of the building in case of accident. By simply pushing a button two magnets in engine room are caused to attract a small armature, the result of which is that a little bolt is shot, and off goes the governor belt of the engine. The result is that the steam valves are disengaged and the engine comes to a standstill. Anyone who understands the construction of the Wheelock engine will readily see how this is accomplished. The main drive is a rope transmission, and the device spoken of above is so arranged that should any of the ropes commence to break or give way, the engineer is at once notified, as the engine stops. The motto around this steam plant appears to be "Cleanliness is next to Godliness," for everything is clean and bright; there is a place for everything and everything is kept in its place. Mr. Green is justly proud of his plant, and the writer takes this opportunity of thanking him for the few pleasant hours he spent in Guelph in the company of himself and family.

Yours truly,

A. E. EDKINS.

OTTAWA NO. 7 C. A. S. E.

At the inauguration of the above association briefly referred to in the NEWS for February, Mr. Edkins, President of the Executive, addressed the members on the objects and aims of the Association as follows:

I can assure you that the Canadian Association of Stationary Engineers as a body, and myself and brother officers of the Executive Council in particular, are very proud of the engineers of the city of Ottawa for having made such an excellent start as a branch of the Canadian Association of Stationary Engineers. When I first communicated with Bro. F. Robert, with a view to forming an Association in this city, I expected that it would (if started at all) be composed of not more than 15 members. I was, to say the least, very much surprised when I received word that you had determined to organize with 34 members. This is the best start which we have had, with the exception of Montreal No. 2, which is composed of engineers of French Canadian nationality, and which started out with nearly 100 members.

Taking into consideration the size and population of the different cities, and the number of steam plants in each, this Association must be regarded as being a credit to Ottawa and to yourselves as engineers.

The main object of the Canadian Association of Stationary Engineers is to unite engineers for the purpose of instruction, and to assist members who are out of employment to secure the same. A large number of manufacturers have looked upon the Association with suspicion, believing that it was instituted for the purpose of creating strife between the members and their employers in regard to wages. This is not, nor was it ever the object of this Association. What we do in regard to the wage question is this: We hold our meetings twice a month, and after the routine business has been disposed of, an hour or more is spent discussing different problems such as are met with in the daily work of a stationary engineer. If a brother engineer meets with any difficulty with the machinery under his charge he can bring it up before his Association and get the benefit of the experience of others. To facilitate this feature most of the Associations have a small box, which is placed outside the meeting room door. If any brother wishes to ask a question, he can put it in writing and drop it into the "question box" before entering the room, and when "Good of the Order" business is reached, the conductor brings in the box to the President, who reads the questions out to the meeting. It often results that a general discussion takes place, and the member who asked the question, generally gets the information he needs, while at the same time no one knows who is asking the question. This method has given excellent satisfaction in other Associations and I commend it to you for consideration.

Each Association has also a blackboard, and we make it a point to try to have some member give something in the line of figuring out a problem at each meeting. In this way we are educating each other to fill better positions when they turn up, and also making our services more acceptable and worth more money to our employers. There are but few men who own steam plants who would not be willing to pay an engineer a little more for his services if he could prove conclusively that he had the ability to run his plant in an economical manner. There are lots of men running steam plants who have not had the necessary experience as firemen to make them engineers, and consequently are not worth the salary they are paid, even though it be small. On the question of wages, then, what the Association endeavors to do is, to unite all practical stationary engineers who have had at least three years experience in charge of boilers and engines, (or as firemen) for the purpose of meeting together socially and for mutual instruction in our calling. It would be worse than nonsense to set up a scale of wages for engineers, as what would be a fair remuneration for a man on one plant, say of 200 H. P. would be out of the question on a plant of 30 H. P. in a small factory.

What we believe is this (and the past experience of the C. A. S.E. proves its correctness), that merit will bring its own reward, and if an engineer is sober, steady and industrious and makes himself competent, he is bound to be successful in his calling. I could give you the names of engineers who were receiving wages at the rate *of $9.00 per week less than four years ago,* who to-day are in responsible positions, and are holding the same with credit to themselves and the C. A. S. E. These men joined the Association, attended the meetings, and took an active part in the proceedings, thereby fitting themselves for a better position, and when such a position turned up they got it.

Some people are inclined to think that owing to the rapid strides made by electricity as a motive power during the past few years engineers will soon all be out of a job. I take a far different view myself of this matter. In fact I consider that the outlook for experienced and practical stationary engineers never was better. I am aware of the fact that many small plants have been converted to electric powers, but in these places the owners nine times out of ten never did employ an engineer. Where there is water power, of course, some of these engines are replaced by motors, the current for which is generated by water power, but on the other hand large power stations are being erected all over the country, and in each of these places a staff of competent engineers will be required, and will receive good remuneration for their services.

It is becoming very plain that we must bestir ourselves, if we intend to keep up with the march of progress in steam engineering. Steam and electricity are coming into closer and nearer quarters each year, and you can hardly enter the engine room of any large factory now without seeing a dynamo, used either for lighting or power. The men who are expected to take charge of this machinery are the engineers. In this connection the benefit of these Associations again becomes apparent, as the engineer who has had experience in handling electric machinery can give practical pointers to other members who have not as yet, but may at any time be called upon to take charge of such machines.

As many if not all of you are aware, we have tried on several occasions to get a Bill passed to provide for the licensing of stationary engineers, but so far have been unsuccessful in our endeavours. *Two years ago the Ontario House passed a Bill* providing for the examining of and granting certificates to all stationary engineers who wished to pass. They incorporated a Board for this purpose, of which I have the honor of being a member. Quite a number of engineers have taken out certificates under the Ontario Act, but we are not satisfied yet. It is only a matter of time, and not a very long time either, before every engineer will be forced to prove to the authorities that he has had the necessary experience to enable him to take charge of a steam boiler and engine, and thus give a guarantee that the lives of employees in factories and shops are reasonably secure during their hours of toil. Some engineers fight shy of such a legislative measure, for the reason, as they say, that they lack education, without which they appear to think they would be unable to pass their examination. This is a mistake on their part. I can assure you that the Canadian Association of Stationary Engineers does not wish to secure the passage of any legislation which would put a man out of a position which he had proved his capability to fill, perhaps by many years of efficient service as engineer, even though he might be lacking in education and theory. What we desire is to elevate our calling to a fair standard, and prevent manufacturers from employing teamsters, clerks, grocers and shoemakers to fill positions as engineers. There are plenty of men who have had experience as firemen and engineers to occupy all the positions, without causing any inconvenience to the steam users in securing men who are experienced. It is not necessary for a man to be well up in theory and figures to enable him to become a proficient engineer, but if an engineer is inclined to study and work himself up in theory, in addition to his every day practice, I have not the slightest hesitation in saying that he will find himself well repaid in the shape of better wages, and a more agreeable position where there is less manual labor and more thinking. We must bear in mind the old saying, there is always room at the top. In conclusion let me say that you will be certain to have your own little troubles in the Association just the same as we have had in other cities, but these need not seriously impair your progress if you live up to the obligation which you have taken, and try to remember the fact that because a brother holds a different opinion from yourself on any subject he is not in consequence a know-nothing. Every man has his own opinion, and every man should respect the opinion of another, even though it may not accord with his own. If you keep the chief objects of this Association in view I have no hesitation in saying that you will one and all greatly benefit thereby.

I again congratulate you on the grand start you have made in organising an association in this beautiful city, and I sincerely trust that Ottawa Association No. 7 may have a long and useful life before it, and that the time may never come when you shall reget the step you have taken to-night in becoming a part of the C. A. S. E.

SPARKS.

The consolidation of the three electric lighting companies at Ottawa is said to be under consideration.

Nearly 2,000 electric cars are running in the United States. Boston alone has about 100 miles of electrically operated roads. Several systems have been developed to a perfection that insures smooth and regular service. Other systems are all in the experimental stage.—*Scientific American.*

According to the decision of the Supreme Court of Minnesota, in the case of Matz vs. St. Paul City Railway Company, standing on the rear platform of a moving street car, even when there is room inside, is not, under ordinary circumstances, negligence per se, at least in the absence of any published rule of the carrier forbidding it.

The capital stock of the Hamilton Electric Light and Power Co. has been increased to $300,000. At the annual meeting held a few days ago, the following officers were elected.—R. Thomson, president, J. M. Lottridge, vice-president; J. V. Teetzel, Q. C., secretary treasurer; directors, Robert Evans, Ald. D. R. Dewey, John Knox, of Hamilton, and H. M. Pellatt, S. F. McKinnon, A. H. Campbell, Toronto.

It has been known for many years that lead pipes frequently suffer from corrosion when laid in certain kinds of earth, while certain waters eat away the inside. During the discussion on a paper on "Cables" at a meeting of the students of the Institution of Electrical Engineers, Mr. A. T. Weightman mentioned the case of the Loch Katrine water at Glasgow. He stated that this water contained free carbonic acid, which attacked the lead, and that the fault was corrected by treating the supply with chalk. He proposed, therefore, to imbed lead-covered cables in chalk.

The silvered copper wires, as well as the gauze, employed in the brushes for dynamos have several inconveniences. On the other hand, carbon has not yet received a fair trial. A Paris manufacturer has constructed brushes formed of metal plates, from 0.2 to 0.3 millimetres thick, with a basis of copper. The plates are folded and placed one upon another, until the number is sufficient to attain the necessary thickness. These brushes are said to do away with sparks, and lessen the wear and tear of the commutator. Only experiments of long duration will enable the real value of these brushes to be determined.—London *Electrical Review.*

It is found from experience that a short fuse will carry more current than a long one before blowing. This is on account of the terminals conducting the heat away rapidly and so cooling the fuse. It is also found that the current required to blow a fuse will depend to a considerable extent upon the size of the terminals. The necessary length for a fuse will also vary with the amount of current it carries. For instance, the fuse in a line of five lamps in series on a 500 volt circuit, taking ½ ampere, need be only ⅜ of an inch long, while a 200 ampere fuse on a 500 volt circuit should be 4 or 5 inches long.

A comparison of the constituents of some of the different forms of light shows the following proportions :—

	RED	GREEN	BLUE	VIOLET
Sunlight..................	1.4	1.6	0.5	0.1
Electric Light..............	2.0	1.0	0.8	1.0
Paraffin	3.0	0.06	0.2	0.1

It will thus be seen that the electric light contains a smaller number of those rays which belong to the red end of the solar spectrum, and in this respect most nearly resembles the sunlight, next to the electric light comes the paraffin, and last of all gas. It has been proved that the rays which belong to the red end of the specrum, that is, those of the greatest wave length, are those which are most liable to irritate the retina. In this respect, therefore, electric illumination stands out as superior to its opponents.

The Montreal Auer Incandescent Light Company has been incorporated at Montreal with a capital stock of $1,000,000, to manufacture and supply electric energy for commercial purposes. The Auer incandescent light is produced from ordinary illuminating gas by a special form of burner attached to any existing gas-fitting. A cotton woven mantle, about 2 in. in diameter and 7 in. long, is dipped in a solution of the salts of a refracting metal obtained from menazite. It is then wrung out and dried over a former to give it proper shape. The mantle is then set on fire and the cotton is entirely consumed, and the heat converts the salts of the material into an oxide. The mantle is then placed over the blue flame of a Bunsen burner, which brings it instantly to incandescence. It is claimed that the cost of this light is very much less than that of ordinary gas, while the illuminating power is much greater. The inventor is Dr. Carl Auer, a native of Austria and a graduate of Heidelburg University.

Mr. Corliss used to get rid of the necessity of steam jackets, and a good many other inconvenient things, when he furnished a power plant, says *Metal.* His steam cylinders, considered in themselves as power producers, did not seem particularly economical. But the weak point of the engine he supplemented by strong points in the boiler end of his combination. His vertical tubulars were so arranged that he could get steam into his cylinder superheated enough to overcome the effects of initial condensation. He once said. "I want to sell power and power plant, but I don't care to furnish a boiler for some one's engine; nor an engine for Tom, Dick and Harry's boiler." The secret of his great economy was in the designing of every part of the plant to harmoniously combine in producing the one desired result.

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Correspondence is invited upon all topics coming legitimately within the scope of this journal.

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"THE Storage Battery. A Canadian brings it up to a state of perfection that knocks the trolley cold!" is among the latest startling information in the electrical line furnished to the public through the Toronto press. It strikes us we have heard something akin to this before.

THE Governor of New York State believes that the canals can only compete successfully with the railways in the carrying of freight, by adopting electricity as motive power. He points out that ample water for the generation of electricity is available at various points along the Erie Canal. The same could be said of the Canadian canals, and it is not unlikely that the idea will be put into operation.

THE Canadian *Patent Office Record* usually reaches us about three months behind time, the wrapper bearing the words "On Her Majesty's Service." We do not know how far a service of this character is satisfactory to Her Majesty, but to everybody interested in the subject of patents it is next thing to being no service at all. Nineteenth century methods evidently do not prevail at the Government Printing Bureau.

IN view of the amount of attention which is being drawn to various schemes for transmitting power from Niagara Falls, and as a commentary on the discussion on this question which took place at the recent session of the Canadian Electrical Association, it may be mentioned as a significant fact that the Niagara and Queenston Electric Railway Company, who intend utilizing the power of the Falls for their line, are actually building a steam power house at the lower end of the road at Queenston, thus demonstrating that the engineers of that road consider it cheaper to use steam power—although they will have a water power in operation at the Falls—than to transmit that power only a distance of seven miles.

MR. THOS. A. EDISON, replying to the enquiry of the Toronto *Globe* as to the practicability of transmitting to the City of Toronto by means of a cable across Lake Ontario, power generated at Niagara Falls, expresses the following opinion: "The laying of a power cable under water is the only practicable method of accomplishing what you desire, for the reason that an aerial line would be affected by lightning. It is perfectly practical to convey 20,000 or 30,000 horse power to Toronto from Niagara by submarine cable. The following questions occur to me, however, in this connection.—(1) Would not such a cable as the one proposed be liable to be disturbed by ship anchors? (2) Is the project commercial, and if effected could it compete with a quadruple expansion engine, with automatically stoked boilers, situated in Toronto itself? My impression is that the last named method would be the more commercial, notwithstanding the high price of coal in Toronto."

THE interior of the Toronto public library building was recently remodelled, and is in consequence much better adapted than formerly for its purpose. In view of the expense which has been put upon the building for the purpose of increasing its attractiveness and usefulness, it is to be regretted that the means have not been discovered to prevent the public reading room from being used as a place of shelter in winter by persons of the dissipated class, whose presence in some cases is so offensive as to make the atmosphere unendurable beyond a short period. Rather than be brought into contact with persons of this class and be obliged to inhale the impure atmosphere which is due to their presence, the respectable reading public is forced to forego to a large extent the advantages to be derived from frequent visits to the public reading room. We can quite understand the difficulty which may be experienced in attempting to exclude the undesirable class of persons to which we have referred, but it ought not to be an impossible task, and in the interests of the reading community it should be done.

THE City Council of Kingston is still laboring with the question of improved street railway facilities. It is evident that the advantages of the electric system have impressed themselves upon the minds of the citizens and their representatives in the City Council. While there is a strong desire to enjoy the improvements which this system would confer, there seems to be a disposition to impose such conditions as are likely to prevent any company from undertaking to introduce it. An offer has been made to Mr. B. W. Folger of a 40 years franchise, on condition that he shall pay to the city 5 per cent of all yearly receipts above $20,000. It is understood, however, that this franchise is not to apply to all the city streets, but only to those on which cars now run. It is said that Mr. Folger does not feel disposed to accept this offer, and it is probable, as stated, that more liberal conditions will be required before the citizens of the Limestone City will be able to experience the benefits of rapid electric transit.

RUMORS have been abroad of late, that a movement was on foot by the Canadian General Electric Co., for the purpose of securing control of the Royal Electric Co., of Montreal. Mr. Thibeaudeau, president of the Royal Electric Co., denies that there is any foundation for the report, which would appear to bear on its face the stamp of improbability. The General Electric Co. has already absorbed a number of smaller concerns, and owns and operates several street railways and lighting plants, which would seem to be sufficient to occupy its attention and capital. We do not believe that the entire electrical business of the country can be controlled by a single corporation, and any attempt in that direction would be likely to have unprofitable results. In this connection a Montreal syndicate is credited with being engaged in the endeavor to have legislation enacted in the Dominion Parliament which would enable them to buy up and operate all the electric light and gas companies in Canada. If such rumors were likely to be realized, a considerable proportion of the business community might well be on the look out for a country where absence of the combine system would enable them to earn a living.

THE severity of the present winter has served to call attention to the necessity for vestibule cars. The duties of the motormen in Montreal, Toronto and Hamilton, difficult enough at any time, have been rendered doubly so by exposure to snow and frost. It is to be hoped that before another winter shall arrive something in the way of protection from the elements will be provided for them. The comfort of the passengers would thereby also be promoted. In this connection we observe that a bill has been introduced into the Illinois Legislature, making vestibuled cars compulsory on all power lines, The main section of the bill is as follows: All operators of street car lines as common carriers in this State shall provide the motor car—that is, the car upon which the driver, motoneer, or gripman performs his duty—with a vestibule apartment for the protection of said drivers, motoneers and gripmen from inclement weather, said vestibule apartment to be appropriately constructed of double glass framework, so that between the panes of glass, there shall be room for a layer of atmosphere of sufficient thickness to prevent accumulation of frost on glass, so that the view of observation of said driver, motoneer or gripman shall not be obstructed. The operators of any street car lines who shall fail to comply with the provisions of this act within six months after the passage of the same shall be subject to a fine not less than $100 nor more than $500 for each and every month compliance with the the same is deferred. Any laws pertaining to common carriers of cities of this State conflicting with the act are hereby repealed.

THERE seems to be considerable difference of opinion among some of those prominently connected with electrical industries in this part of the world as to whether or not it is practicable to carry current at high voltages and over long distances and sell it at such a price that there will be a saving to the users over the cost of generating the same amount of current by the consumption of coal on the spot. One of the long distance schemes on hand is that of Mr. John Patterson, of Hamilton, who proposes to bring at least 5000 H.P. from Niagara to the city of Hamilton for the operation of electric railways and divers other uses. Whether it will be a success or not, or whether it will ever be attempted to be carried out, remains to be seen. We are in a position to state positively, however, that Mr. Patterson has a direct and positive tender from Siemens & Halske, of Chicago, in which they guarantee to transmit that amount of power at a pressure of about 18,000 volts. They also guarantee to deliver in Hamilton 73 per cent. of the power consumed at the Falls, the system used to be alternating, with step up and step down transformers, alternating current motors to be used throughout, both on the cars and on any that may be stationary. Should the undertaking be carried out, and it looks at present as though it might be, there will be great interest taken in it both in Canada and the United States, for it will be the first of its kind in America, unless the Niagara Falls scheme be started ahead of it, which would seem at this time to be extremely doubtful. True, if it can be done here, it can be done there. The Patterson scheme seems to have advanced too far to permit of a drawback. Should it fail, it will, to say the least, put Mr. Patterson in a queer position, as the company's charter has been granted, some of the stock has been subscribed for, and it only remains to begin the work of construction. This we are assured will be started in a little while, in which case the project will be regarded with world-wide interest.

FIRES CAUSED BY STEAM PIPES.

THE New York *Spectator* of February 16th has the following:

"Several theories have been advanced as to the probable cause of steam pipes igniting wood. One, that the constant heating has carbonized it, and as carbon has an affinity for oxygen, corrosion takes place and ignition ensues. Another theory, published some time ago in *Power*, attributes the result to the same cause, but by the corrosion of the steam pipes. None of these theories are corroborated by the authority of men who have spent a lifetime experimenting on this subject.

"In 1886 this subject came up for discussion in a civil engineer's club. The president requested its members to make a thorough investigation of the matter and to present papers upon the result at subsequent meetings. The writer conducted a series of experiments, and read a paper upon the result of his investigation to the club, which was accepted and ordered printed in their monthly issue. The writer, in his experiment, has ignited at will the wood coming in contact with steam pipes by allowing the water in the boiler to run low, which happens more often than the engineers are willing to admit. When one-half of the heating surface is uncovered by water the steam gets superheated, during which time the pipes are visible in a dark room by their glow. A boiler may also foam under the care of the most careful engineer, and not a drop of water will remain in it regardless of the glass gauge or the frequent tests of the petcock. A glass gauge cannot be relied upon, and the petcock will indicate water in a foaming boiler until a very small quantity of it is left. The first indication given to the careful engineer is the smell of the burning oil in the cylinder of his engine. At that period all pipes in the building are red hot. The engineer, well knowing that his employer would accuse him of neglect—and he would probably lose his position if the facts were known—he banks his fire and with a trembling hand slowly starts his pump. The engine has kept its motion, all the machines have kept running, but during that short period all the steam pipes in the building were red hot, the wood in contact with it has ignited, and the conflagration will start a little later.

"No truthful engineer will deny that at some period of his life his boiler has foamed, as no human knowledge can foresee this occurrence, but few will ever admit that the water got low in their boiler when no foaming existed. Still, the writer knows that it often occurs, and to this occurrence can be charged the heavy losses that the underwriters are called upon to pay.

C. T. AUBIN, Civil Engineer."

Philadelphia, February 6.

The signature professes to be that of a civil engineer. When we were boys we used to be told that a civil engineer was an engineer that was civil. The definition hardly holds good in this case; or if it does, then the *Spectator's* Mr. Aubin is no engineer. It is quite evident he does not belong to the Stationary Engineers, else he would not malign his brethren. He is not a blacksmith, because he can make iron pipes red hot without putting them in the fire. He is not a boiler maker, because even a boiler maker has more sense than to expect a boiler to go on quietly with its work after being red-hot and empty, and pumped full of cold water again. He claims to be able to keep the engine running steadily after every drop of water is out of the boiler. What a pity that any should ever be put into the boiler if such can be done, especially in cities where water costs so much. We have pondered over the matter, and have come to the conclusion that Mr. Aubin has either made one of the great discoveries, such as have enlightened the men of this century, or that a portion of the address given has been inadvertently left out. We suggest to our friend, the *Spectator*, that the article will be much more intelligible to steam engineers if after the word "Philadelphia" there should be added the words "Lunatic Asylum."

ENGINES FOR ELECTRIC LIGHTING.

II.

In the former article on this subject some suggestions were made as to the probable causes of unsteadiness or jerkines in the motion of electric machinery driven by high speed steam engines. These suggestions were applicable only to cases in which the machinery is driven by one engine of the single cylinder and single crank type. It is common to find such engines used, and as they are generally connected to the dynamo by belting, the jerking is aggravated by the belt slipping at times.

Variations in the load are not responded to quickly enough by the common style of engine governor, and where changes of load are frequent, or, great in amount, as compared with the whole load, the engine's speed will be constantly varying. In this respect the long stroke engine, with larger fly wheel and driving a main shaft and counter shafts, will be found to have an advantage, especially if the driving shafts have heavy and well balanced pulleys. Small variations of load will not perceptibly affect the motion of the total mass of shafting, pulleys and belts, and if the change of load be a great one, time will be required to change the speed of all the shafting, and in that time the governor will have acted on the steam supply. The governor would be much quicker in its action if it were attached to and driven by the dynamo instead of the engine; or there might be a supplemental governor on the dynamo to assist the one on the engine. Where there is a considerable amount of power required constantly, with or without extra demands during certain hours, the steadiest motion will be got by having at least one large engine driving a main shaft, from which the various dynamos may be driven by counter shafts. This large engine should have at least two cranks and two cylinders, and will be even better if made with three cranks on the one shaft.

When two cranks are used, the one cylinder has its piston at highest velocity when the other is at the turning point, and has no velocity. The average power of the two is thus made much more constant than can be got from any single crank arrangement. When three cranks are used the equilization is still better than with two, and by far the best motion is thus obtained.

All attempts to get rotary motion directly produced by means of steam have so far not been commercially successful. Hundreds of rotary steam engines have been made, but none have been used for large powers with economy. The water wheel with a good governor produces a very steady motion, and is free from the jerkiness produced by changing the reciprocating motion of the steam engine into rotary motion for the dynamo.

It has been proposed to pump water into a tank by means of a steam engine, and use the water through a turbine wheel to drive a dynamo. The same water would then be pumped back again, just as is now done in many cases with hydraulic elevators. This scheme has a more important bearing, in considering how best to provide power to meet extra demands which are made during only a few hours of each full day, and will be considered when that part of the subject is taken up.

Where space is of great value, or where in addition to unsteadiness and jerkiness in the motion, the vibration of the machinery acting through the ground on the surrounding property has to be avoided, it is found that the vertical engine of the marine type is the most successful. This type has for a number of years been used for screw propulsion on board ship and the necessity for economizing in space and in fuel used, led to improvements in design and proportion, so that it is to-day in the front rank in these respects.

The Edison General Electric Co., of New York, have made quite a number of this style, using three cylinders for triple expansion and three disc cranks on the one shaft. In some cases there is a dynamo at each end of the shaft. One of these engines, rated as being of 700 horse power, has cylinders of 16¼ inches, 23¾ inches and 38½ inches diameter and length of stroke is 30 inches. The piston speed is 600 feet per minute—steam pressure carried in boilers is 160 pounds per square inch. Each cylinder has a cut off controlled by a governor in the disc crank. The range of cut-off is from about one-twelfth of the stroke to nearly three-quarters.

In some experiments the change of speed was less than 2 per cent. between full load and no load. This company is now proposing to use higher pressure of steam and to make quadruple expansion engines, using only two cranks and having two steam cylinders one above the other working down on each crank. When this four cylinder engine has its proper load it will probably be more economical in fuel, but there will be less steadiness in motion, and more vibration. The dynamos used are of large diameter, as the speed in revolution per minute is only about 120 when connected directly on the engine shaft. The triple and quadruple expansion engines, if run with light load will be found wasteful; and in order to keep up their high economy should be properly proportioned for the pressure of steam and load. The Edison Company have been using an electric accumulator, so that when the dynamos could produce more electricity than was called for on the circuit it might be stored up for use at another time. By this means a sufficient load for economy could always be kept on the engine.

For economy in space and in fuel and for freedom from vibration and steadiness in motion, the triple expansion vertical engine with dynamos connected directly on engine shaft is undoubtedly the best motive power yet produced. Such engines when water can be had for condensation, can be run on one pound and a half of coal per horse power per hour, that is when run with sufficiently uniform load and with boilers of the right design.

In the next article it is proposed to consider how best to provide for change of load, and to meet the extra demands made during certain hours.

ONE FOOT FALL OF WATER.

OTHER things being equal, the horse power that may be got from a stream or fall of water is directly as the amount of head or fall, that is, double the fall gives double the power. As one horse power equals the amount of work expended in lifting 33,000 pounds one foot high in one minute, or its equivalent, it follows that in order to get one horse power we must have at least 33,000 pounds of water falling one foot high per minute, or its equivalent. There will, of course, be some loss in conversion or generation, so that when we figure 33,000 pounds of falling water one foot in a minute as giving one horse power, we must understand it as meaning one maximum theoretical horse power. Practically we shall get only from sixty to ninety per cent. as much.

As the weight of one cubic foot of water is 62⅓ pounds (not 62½, as generally quoted) and that a standard United States liquid gallon practically 8⅓ pounds (say 7½ gallons per cubic foot), it is perfectly feasible for us to get up a set of multipliers showing the maximum horse power developable by any given number of cubic feet or of gallons of water per day, per hour or per minute falling one foot; and from this the horse power for any other fall can be obtained by simple multiplication. Such a table is here presented:

1,000,000	pounds per	minute	30.303 h. p.
1,000,000	"	hour	.50505
1,000,000	"	day	.02104
1,000	gallons per	minute	.2525
10,000	"	minute	2.525
10,000	"	hour	.0421
10,000	"	day	.00175
100,000	"	minute	25.2525
100,000	"	hour	.4209
100,000	"	day	.0175
1,000,000	"	hour	4.2088
1,000,000	"	day	.1754
1,000	cubic feet per	minute	1.8879
1,000	"	hour	.0315
10,000	"	minute	18.8788
10,000	"	hour	.3146
10,000	"	day	.0131
100,000	"	hour	3.14646
100,000	"	minute	.1311
1,000,000	"	hour	31.4646
1,000,000	"	day	1.311

With a ten-foot fall, one horse power would call for at least 396 gallons, or 51.364 cubic feet per minute, and this would go in a cubical box 3.71 feet on a side, in the clear.

Assuming that the water wheel gave out eighty per cent. of the maximum theoretical power of the water, the amount of water needed to produce an actual net horse power will be found by dividing the theoretical figures by 0.80; that is, there would be needed 4.950 gallons instead of 3.960, and so on.—*Dixie.*

SPEED CONTROL.*

There are but few classes of machinery which do not require some control to be exercised over their speed, and probably in this respect none are more rigorous in their requirements than the dynamo. It is to this point that the present paper is directed.

Confining our attention for the moment to shunt and compound wound dynamos, we can see that 1% increase in the speed must produce a greater increase than 1% in the electro-motive force, since the field strength is increased by the increased voltage applied to the shunt coils. For example, suppose that an increase of 1% in the voltage at the shunt terminals would produce ¾% increase in the field strength; this would again produce a further increase of ¾% at the shunt, which would produce ¾% of ¾% or 9/16% increase in the field strength, and consequently in the voltage. The final result is then that we have 1 + ¾ + 9/16 + 27/64, etc., as the percentage increase corresponding to 1% increase in speed; this amounts to 4%. Similarly, if the dynamo be worked at that point in its magnetization curve, at which 1% increase in the ampere turns produces 9/10 increase in the field strength, a similar calculation would give 10% variation in voltage for 1% in speed. In an actual instance, an Edison 6 kilowatt, 110 volt dynamo, varied nearly 3% in voltage for 1% in speed.

Such considerations would apparently lead to the conclusion that it might be worth while to waste rather more power in the field coils, thus bringing the field nearer to saturation, if we value constancy in the voltage.

When we consider any problem relating to the dynamical generation of electricity, such for example as the maintenance of constant voltage in spite of load variation, the fact is brought forcibly before us that the dynamo is but a part of a system through which there is a flow of energy, from the heat energy of the coal, through that of the steam, to the electrical energy of the dynamo, and thence on to the heat and light of the lamps, or the work done by motors. This energy is, as we know, indestructible, but some of it is as if it were side-tracked on the way in the form of heat in exhaust steam, heat of friction in the engine, loss in conductors, etc., so that to find our original energy we must hunt in many places for it, and add the separate parts, for that energy which is to pass on the way must be free, free at every instant for just that flow of energy that is demanded; more or less will not do; if 1,000 lamps are lighted, energy is required at the rate of 1,000, if it be supplied at the rate of 1050, the life of the lamps will be reduced, or if at 950 they will burn dull.

Suppose for example the problem is to maintain 500 volts between two mains in spite of all demands for current, power being derived from a steam engine with automatic cut-off; 100 amperes has been flowing, and the governor is holding the cut-off at such a point that the mean torque produced by the steam is that required for 100 amperes. Suppose that 50 amperes more are suddenly required on the line, the cut-off, of course, still holding to the point corresponding to 100 amperes. For the instant, the series coils compensate the inevitable drop due to the extra current; more energy is then required than is being supplied by the engine, and the result is that the rotational energy of the fly wheel and armature is drawn on to supply the difference. Suppose in this instance the engine runs at 100 revolutions per minute and has a fly-wheel 12 feet in diameter weighing five tons, in 1¼ seconds the speed would have fallen to 99 revolutions, the governor's effect not being considered. Now, the action of the governor (which we may suppose to depend on centrifugal action) is by no means simple, depending, as it does, on the position of cut-off for the new load, the speed corresponding to this position, the time required to pass from one position to the other, its dead beat quality and the effect of friction. If this governor be frictionless, dead beat, and has no time lag (this last, however, being practically impossible), and if the speed for the new point of cut-off be 98, then in one second the speed will fall to 99⅓, in 1¾ seconds to 99, and in 3½ seconds to 98½, ultimately reaching 98, and there remaining.

The principal objections that can be raised to this method of governing by speed are then that they must wait for a change of speed, accompanied, as we have seen, by a comparatively large change of voltage, to occur before they can act; they cannot act instantly, even when the change has occurred, and for each change of load there is a certain change of speed which the governor not only cannot prevent, but will even insist on maintaining. Now, the question, which seems to be well worth discussion, is, how far may these defects be remedied by another method of governing? Suppose, as in the case we have considered, a so-called constant potential dynamo receives its power directly from a steam engine, then it is clear that if friction remains the same the steam admission required depends only on the current, each current having then for the same boiler pressure, a definite position of cut-off corresponding to it.

If we have then determined these positions and arranged a mechanism so that the cut-off is immediately placed at the point corresponding to the instantaneous current, the proper energy would be supplied at every stroke to meet the demand, and no sudden accumulation of energy in the form of increased speed of rotation could occur. But the question now arises, should such a governor be allowed to assume entire control of the engine or not? that is, would it prevent an increase or decrease in speed from gradually arising? Suppose for example that the governing mechanism sets the cut-off in error by a certain amount, say 1/16" in advance. What it would be useful to know is, whether the speed would continually diverge from its normal value, or whether it would merely change slightly and then remain constant. In order to obtain some light on this question, the following experiment was made, for assistance in connection with which I am indebted to Messrs. W. T. Lea and C. G. Milne. The points of cut-off in a Brown engine corresponding to a number of different values of mean torque at 88 revolutions per minute were determined. In this way the two points of cut-off corresponding to 290 and 337 pounds respectively at the circumference of an 8-foot wheel were determined. The engine would run uniformly at 88 with either load with its corresponding cut-off. An experiment was then made to decide the question, what would be the effect of setting the cut-off for a 337 pound load, the actual load being only 290. The result obtained shewed that this difference in steam admission produced only a permanent increase of 7 revolutions per minute. There seems, however, to be no reason to suppose that a governor whose action thus controls the cut-off by the load instead of by the speed, should ever make an error approaching that of substituting 337 for 290, and if so it is possible that the governor might work sufficiently well.

In the case of turbines and jet wheels it appears more probable that such a governor would perform its work satisfactorily, for if too much water were admitted, rendering the torque too great, the tendency of the increased speed produced would be to lower the impressed torque. Some curious effects are sometimes produced by special conditions in the transmission. For instance, a gas engine is driving a shunt wound dynamo which is charging accumulators; if all resistance be removed from the circuit but that of the cells and dynamo, the total resistance is low, and a very small excess of voltage in favor either of the dynamo or of the cells will produce a considerable current either way and the current is consequently very unsteady. If, however, the gas be forced to explode every time, instead of as often as is permitted by the speed regulation, the effect is that it runs at such a rate that the dynamo voltage will be just so much in excess of that of the cells that the torque produced by the charging current will be that which corresponds to the mean torque due to the explosion, after making due allowance for friction. The effect then is practically to control the speed of the dynamo, so as to make it a constant current instead of a constant potential machine.

On motion of Mr. Wickens, seconded by Mr. Thomson, a vote of thanks was accorded to Prof. Rosebrugh for his paper.

* Paper read by Prof. Rosebrugh at the second convention of the Canadian Electrical Association, Jan. 25th and 26th, 1893.

SPARKS.

Aylmer is considering a proposal to have its streets lighted by electricity.

A patent has been granted to A. H. Brintnell for an electric propulsion car.

A telephone exchange is being established at Chicoutimi, Que., by Messrs Guay & Co.

A wood-workers' journal states that electricity is likely to be made use of in saw and planing mill operations.

The Bell Telephone Company's system at Peteboro', Ont., is to undergo reconstruction under the direction of Mr. G. L. Shaeffer.

The adoption of electricity for lighting, and a telephone system, is under consideration by the citizens of Tatamagouche, N. B.

The Niagara Falls Park and Electric Railway Co., are said to be considering the question of erecting a tower on their property.

The Bell Telephone Co. has recently taken over the business of the Farmers' Telephone Co., of Waterloo, and will improve the service.

The Board of Trade of Collingwood, Ont., recommends the Town Council to duplicate its present electric lighting plant, so as to maintain the lights in case of accident.

A committee has been appointed by the city council of Berlin, Ont., to consider propositions which have been made for the organization of a new electric railway and light company.

The Toronto Public Library Board has appointed a committee to consider and report upon the best method of lighting the building. The purchase of a lighting plant is under consideration.

The C. P. R. Telegraph Co.'s operating staff at the House of Commons, Ottawa, recently despatched in one night to Canadian newspapers 173,000 words, the highest record yet attained.

Application will, it is said, be made to the city council of London, for a franchise to produce electricity for street, factory, store and residence incandescent lighting. The project is believed to be directed by the General Electric Co.

The Winnipeg Horse Car Company is appealing to the full court of Manitoba for an injunction to restain the Winnipeg Electric Company from running cars, claiming that it was given a monopoly of the streets by the City Council.

It cost the town of Windsor last year, $6,000 for electric light operated by a plant owned by the corporation. The average cost per light per month was $3.25 which is considerably above the price charged by many private companies.

W. G. Grace, secretary-treasurer of the Street Railway Company, has written to the Mayor proposing that the street railway traffic of both city and country be run on a broad system under the management of the Toronto Railway Company.

The new incandescent light company recently organized at Smiths' Falls, are getting their plant and wires into position. 400 incandescent lights have already, it is said, been subscribed for. The lights will be run all night at 1¼ cents per lamp. Mr. J. H. Gould is president of the company.

A. Cronk, a motorman on the Sandwich Electric railway, recently sprang over the front of his car, and snatched from the track a little child which had suddenly stepped in front of the approaching car. The motorman saw that it would be impossible to stop the car, and took this heroic step for the purpose of saving the child's life.

The annual meeting of the Sackville, N. B., Electric Light & Telephone Co. was held a few days ago, and a favorable report of the past year's business presented. A large number of new telephones and lights have been installed during the year, and a sufficient number of subscribers secured to warrant the extension of the light circuits, for which purpose a new 600 light dynamo will be purchased. Messrs. H. A. Powell, D. G. Dickson, W. B. Dickson, Capt. Wm. Miller and Fred. Harris have been elected directors.

The Royal Electric Company, of Montreal, has purchased an adjoining property of equal extent to the land occupied by its factory and station on Wellington street. It was the intention of the company to erect buildings upon this property at once, to be used as additions to the factory and station, but owing to the lateness of the season this has been postponed till next spring. The new station will be devoted to incandescent lighting, and will have a capacity of 50,000 lights to begin with, making, with the present stations, a total capacity of 125,000 incandescent lights, 1,500 arc lights, and 200 h. p. for power. Its equipment will consist of five 1,000 h. p. vertical compound engines, each belted to two 5,000 light alternators, designed by Mr. Fred. Thomson, the electrician of the company. A special feature of these alternators is the embedding of the armature wire in the armature core so that no binding wires are required. An alternator similar to these is being constructed for the Ottawa Electric Light Company, of Ottawa, and a smaller one for the Quebec and Levis Electric Light Company, of Quebec.

MONTREAL ELECTRIC CLUB.

A very successful paper on "Outside Construction" was read before the members of the above club on the evening of Feb. 5th, by Mr. H. Woodman. Mr Woodman transported his hearers to a supposed town where 100 horse power in motive power, 1,000 incandescent lights, and 120 arcs would be required. The central station was supposed to be located at the outskirts of the town, and Mr. Woodman in a masterly way "laid out" the different centres of distribution, showed how poles were chosen, trimmed and planted. Different reels for unrolling wire were described; also the manner in which wire was to be strung up, "bridled" from "foreign wires," dodged through trees, etc., etc.

A vote of thanks was tendered Mr. Woodman for his valuable paper, which proved of great interest to all.

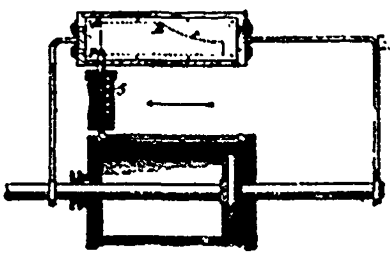
Several new members were balloted for. At the next meeting on Feb. 20th, Mr. W. B. Shaw read an interesting paper on "Storage Batteries," which is printed in this paper.

THE INDICATOR.

In a reply to an inquiry from several of our readers as to the action of the "Indicator" as used on the steam engine, says the *Northwestern Mechanic*, we have prepared the following cut and explanation, hoping that thereby the principle may be shown; although it must not be thought that the instrument used is anything like the one here shown; this merely shows the principle, In the cut will be seen the cylinder of an engine, showing the sectional view, and the piston being at the right hand end of the stroke.

The piston rod is extended out of the cylinder each way in order to make clear that the board above moves with the piston, in fact in this case is moved by it.

The board is shown supported by the arms which run up from the piston rod, and on the board is a sheet of paper tacked on to receive the card or tracing of the pencil, which is held in the place marked P at the upper end of the rod in the cylinder. It will be seen that a small pipe runs from the right hand end of the cylinder to the small cylinder and that there is free connection between the small cylinder and the main cylinder of the engine.



THE INDICATOR.

The piston in the small cylinder is a neat working fit and is forced down by the spiral spring as shown at S. Now we will *suppose that steam* is admitted at the right end of the cylinder (the steam chest and valve being on the side in this case) and we see that the steam having free access to the small cylinder as well as the large one, will force the small piston up; and supposing this takes place before the piston of the engine has moved at all, the line that as drawn by the pencil will be perfectly straight as shown by the dotted line on the paper tacked to the board. Now that the piston has commenced to move, and the board moving with it, it will be seen that as long as the steam pressure in the cylinder (and indicator also) remains the same, the indicator pencil remains at the same height, and the line traced will be a perfectly straight line as from A to B. Now if we let the steam follow full stroke, the line will remain straight to the end of the stroke, but as this is not good practice, we cut off at half stroke. This means that when the engine piston has traveled half of its stroke the live steam is cut off, and the steam then in the cylinder expands, forcing the piston along but of course reducing the pressure as it advances.

As the pressure begins to fall, the spring in the indicator piston forces down the pencil arm, and remembering that the board is continually moving, we can readily see that the pencil will trace a curved line' somewhat as shown. When the exhaust opens (we will suppose it to open and free the cylinder instantly) the pencil falls back to the original position, and on the back stroke traces a perfectly straight line. The dotted outline is called the card, and if we study it, we can see that it represents the work the engine has done during the stroke, the height to which the pencil went as soon as steam was admitted, represents the pressure of steam in the cylinder at the beginning of the stroke. We also see that this pressure was maintained until the piston had made half its stroke, then the gradually falling line shows that the steam pressure was becoming less, owing to the volume of steam contained in the cylinder being expanded to twice its normal volume, and finally we see the pressure line drop, showing that the exhaust was opened and the free escape of steam allowed Then we see that the height of the diagram represents the steam pressure, the point where it begins to fall, represents the point of "cut off;" and the height before the final drop, the terminal pressure, or pacssure still existing when the exhaust is opened and discharged it into the atmosphere.

These exact conditions do not exist in practice, but this will serve to show the manner in which they indicate the performance of the engine.

If we know the steam pressure as it is admitted to the cylinder, we can easily read the card intelligently, but if we do not, the card has much less meaning to us.

This is arranged in practice by having the springs "S," very nicely adjusted in the following manner. A spring is made that will be compressed exactly 1 inch with a pressure of 20 pounds, this is called a "number 20 spring," another is made that will be compressed exactly one inch with 40 pounds, and called a "number 40 spring" so that you can remember, that the number of an indicator spring means the pressure required to compress is exactly one inch.

Now if we know that a 40 spring was used in taking a card, and the card measures 2 inches in height, we know that the steam pressure, when admitted to the cylinder was exactly 80 pounds, and if the height of the line at the other end of the card is ¾ of an inch, we know that the terminal or exhaust pressure must be ¾ of 40 or 30 pounds. This makes the measurement of cards entirely practical if we but know the spring employed. Revising this operation we can see if we wish to indicate an engine whose boiler pressure is 90 pounds, and we do not want our card to exceed 2 inches in height, we use either 45 or 50 spring, usually the latter, as it is best to keep the cards reasonably small.

Of course with the primitive indicator as shown in our cut, we can only indicate the right hand end of the engine, and would require two of this type to fully indicate the engine, but of the commercial kind in use to-day, it is possible to indicate both ends with the same instrument, by only changing the connection at the different ends of the cylinders. Now tracing the evolution from this crude indicator of ours to the finely finished one of the present day, we will see that the board as large as the cylinder is replaced by a very light cylinder or drum, and instead of tacking the paper for the cards to a board, we simply fasten them around this drum. This drum is revolved at the proper time to be in unison with the engine piston, by being attached by means of a cord wound around the base of the drum, to some moving part of the engine; that gives the correct motion.

The movement of the piston in the instrument of to-day is usually multiplied by a very light arm carrying the pencil over the paper and otherwise being much more simple and compact than our crude instrument, but otherwise it might be called similar.

We will at some future time enlarge upon this subject, still in a very elementary way, for we believe that this is the part to be explained and that after any one who is desirous of learning in this or any other branch has got the principle so that he can thoroughly understand it, he will need little further help from us in this way.

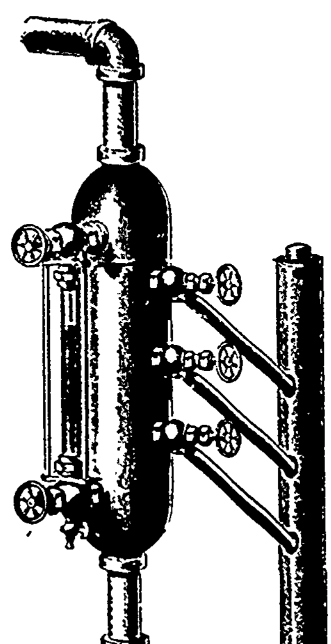
Not that we shall not take pleasure in answering any questions advanced, but we believe it is the elementary part of the subject that needs the most attention. We hope to hear from our readers in regard to this and other kindred tropics, and trust that any point not made clear will be pointed out to us that we may further enlarge upon our crude instrument and the principle it explains.

When the young fireman masters the principle of the indicator, and learns to read and understand the meaning of the cards produced, he is in a fair way to become an intelligent engineer, and to this end we desire to aid him.

CONCERING TRY-COCKS.

Try-cocks are important things, and should be so designed and arranged that they can be used with facility, and without the inconveniences and annoyances that they ordinarily give rise to. As they are usually made, they are apt to leak continually. This in itself is a sufficient annoyance to call for some remedy, and the remedy that is too often applied is to stop up each leaking one by driving a pine plug into it. The wooden handles with which they are provided crack under the influence of the heat and moisture to which they are subjected, and eventually fall off, so that the fireman has to use a pipe-wrench, perhaps, to open them. Even when they are in good condition, and the fireman tries them faithfully, he is probably rewarded by seeing a voluminous spray of mud blow all over his boiler-front; for mud will collect in the connections, even if there is none elsewhere. This trouble is avoided, in some places, bv providing a copper waste-pipe, which receives the dischaige from the try-cocks through small funnels brazed into it on the upper side. Such an arrangement proves very effective and satisfactory when the try-cocks are connected directly with the boiler, but when a water-column is used, and the cocks are directly over one another, it is not easy to arrange such a waste-pipe so that it shall be effective without being unsightly.

The lead or composition seats with which try-cocks are usually provided soften up under the influence of the heat to which they are subjected, especially when high pressures are used; and the fireman, in attempting to close the cocks tightly enough to prevent leakage, often jams the seats out of shape. Part of the seat is forced into the steam opening, forming a nipple, which greatly obstructs the flow of steam. In some cases these nipples are of such length that it becomes necessary to turn the cock till it nearly comes out of the thread before steam will blow through it freely. It is true that the seats can be replaced, but this will have to be done on Sunday or a holiday, when the plumber's irons are cold. Moreover, it requires some time and patience to tin the recess for the filling and get a good job.


A SUBSTITUTE FOR TRY-COCKS.

Another very annoying trouble is frequently experienced. Owing to the smallness of the nozzles of the cocks (usually about 5-32 or 3-16 of an inch), a slight deposit in them of scale or other similar substance will materially check the free flow of steam that should take place. The stems are usually not packed, and the threads are apt to fit loosely. The result of these various circumstances is that when the fireman opens the cock a spray of hot and muddy water blows out through the loose thread, and he receives it, perhaps, in his sleeve. At all events, he finds it unpleasant to use such try-cocks, and the result is apt to be that he trusts implicitly in the glass gauge, and leaves the try-cocks to themselves, plugged up, perhaps, to keep them from leaking.

There seems to be no good reason why ⅜ inch or ½ inch angle valves may not be used in the place of the conventional try-cock, for there are many advantages in such an arrangement, and there is pratically no difference in the expense. The cut shows one way in which this idea may be carries out in pratice. The angle valves are merely subtituted for the ordinary cocks, and nipples, running off at an angle, are screwed into them. A two-inch waste pipe (shown in the accompanying cut) may receive the ends of the nipples, provided the fireman is a man of sufficient experience and intelligence to know the difference between steam and water by the sound it makes, *but we should neither advise nor approve of the use of such a waste-pipe in average practice.* In most cases we should advise that the nipples from the angle-valves should open freely into the air.

By the use of angle-valves many of the annoyances incident to the common try-cock can be avoided. The stems of the valves can be kept packed, so that no trouble from leakage in this direction need be feared. A small deposit of scale makes but little difference in the efficiency of the arrangement, on account of the enlarged area of discharge; and if a troublesome deposit should collect, the bonnet of the valve may be removed, and the pipe, being conveniently large size, can be cleaned out by a small rod or a stout wire. Another point of material advantage in the proposed arrangement is that the seats of the angle valves can be easily removed and replaced by new ones in a few minutes, so that the valves can be kept tight. (It is true that these small valves usually have solid seats, but they can be had with removable seats, if desired.) Under these conditions there will be no temptation to the fireman to neglect the try-cocks.

There is one objection to the use of angle valves that should be considered, though it does not appear to us to be very weighty. In removing and replacing the bonnet of the valve the fireman is apt to use too large a wrench, and to screw the bonnet up with more force than is necessary. The result is apt to be that, after removing and replacing a few times, the hexagonal nut becomes sheared all out of form, so that it is neither hexagonal, nor square, nor round, nor any other particular shape. Then he is apt to call loudly for a new valve. This has been the experience of some few of those who have used angle valves as suggested above, but we think this trouble can be avoided by a few words of caution to the fireman.

We may mention, in this connection, another point that applies equally to angle valves and try-cocks. The tendency in these days is very noticeably towards the use of higher steam pressures than have been used in the past, and along with the higher pressures we must necessarily have higher temperatures to contend with. Thus saturated steam of 60 pounds pressure has a temperature of 307° Fah., while steam of 100 pounds has a temperature of about 338°, and at 125 pounds its temperature becomes 353°. Many alloys that will resist a temperature of 307° for long periods of time soften up so much at 340° or 350° that they soon become unfit for use as valve-seats. In such cases it is found that pure, soft copper can be substituted for the more fusible metal with good results.—*The Locomotive.*

NOVEL SUIT AGAINST A HALIFAX ELECTRIC COMPANY.

IN the case of Chandler Electric Co. v. Fuller, F. was owner of a warehouse in the city of Halifax used for storing iron, and had occupied the same for some twenty years. In 1889 an electric company established a station for generating electricity on the adjoining premises. Attached to the engine used by the company in their business was a condenser, which passed through the floor of their premises and discharged into the dock below, at a distance of some twenty feet from the warehouse. In March, 1889, the warehouse was found to be full of steam, which fact was communicated to the officers of the company, who stated that they could not understand how it could have been caused by their engine. The steam continued to enter the warehouse, injuring the iron therein, and in 1890 an action was commenced by F. against the company for such damage. The company contended as a defence to the action that they were using the latest and best improvements in machinery for their business, and that they operated the same in a proper manner and without negligence; that the injury, if caused by their engine, was due to the defective state of the plaintiff's premises; and that they were acting in pursuance of statutory powers contained in their act of incorporation, and were therefore exempt from liability. At the trial judgment was given against the company, and on appeal to the full court the judges were equally divided. Held, by the Supreme Court of Canada, affirming the judgment of the Supreme Court of Nova Scotia, that the act causing the injury violated the rule which does not permit a person, even on his own land, to do an act which, lawful in itself, yet necessarily causes injury to another; and especially as the injury is continued after notice to the company, the plaintiffs were entitled to recover damages therefor.

The material and plant required for the extension of the Walkerville Electric Railway is expected to arrive on the ground shortly.

STORAGE BATTERIES, SECONDARY CELLS, OR ACCUMULATORS.*

By W. B. Shaw.

It is not my purpose to-night to discuss the above minutely, or to enter at any length into the complex chemistry that accompanies their action, but more to describe in brief how some different manufacturers construct their cells, their apparent reasons for so doing, and other points which I deem of general interest.

I will begin my remarks with what may appear to some a paradox, namely, that a storage battery does not store electricity. This can be shewn by the following simple experiment.—Place two strips of copper in a solution of sulphate of zinc. This chemical, as its name implies, is composed of zinc and sulphuric acid. Now pass an electric current through this, and the zinc will leave the compound and be electro-deposited on one of the strips, leaving the solution sulphuric acid and water. On stopping the current the zinc will be re-dissolved from the plate by means of the dilute acid, in the same manner as a simple cell, and give off a current in the reverse direction.

It is therefore a disuniting of a chemical compound by means of electricity. The atoms of this compound come together again when the current is shut off, and in this coming together cause an electric current to be given off.

In 1803 Ritter constructed an accumulator having platinum electrodes, this has long since been discarded on account of the expensive material used in its construction.

In 1860 Planté constructed one having plates of lead only. This battery has many good points, and several electricians of high standing speak well of this class.

In 1881 Faure constructed one with lead plates, the same being filled with holes, and the holes being filled up with a special prepared paste. This style has also found great favor with different electricians. Sellon's and Volckmar's, E. P. S. Julien, N. Y. Accumulator Co., Pumpelly, Sorly, Roberts, Acme, Woodward, Bradbury-Stone, Ford-Washburn and others, are of this style. The Julien Co. "temper" their lead grids by mixing a little antimony with it; the Pumpelly make their lead grids by pouring molden lead into trays of water, and afterwards filling the interstices with the paste. The Sorly make their lead grids by winding a flat strip of lead backwards and forwards, then filling in the spaces formed with the paste, finally binding the whole firmly together.

The Roberts Co., of Toronto, now defunct I believe, cast 2 lead grids, with a "star" pattern, hollow on one side. The paste is pressed into one, and the other grid placed on top and riveted to i, thus making one plate.

The Woodward (?) is made by pouring molten lead on coarse salt; the salt is afterwards dissolved out in water, and the paste replaces it.

The above are all of the Faure or "pasted plate" type. Now speaking of the Planté or all lead type, I will only mention two of the leading makes, which will serve for illustration.

The Crompton Howell, as used at McGill College, use porous lead, made by *maintaining melted lead almost at the point of crystallization*, and then casting from the semi-crystalline mass, blocks of what may be called lead-sponge, that is to say, blocks which consist of a number of lead crystals, all held firmly together at their points of contact. These blocks of lead sponge are then sawn into plates and formed in the usual Planté method, which is by repeated charging and discharging and several reversings.

The Epstein cell is formed thus direct from lead sheets, or by direct oxidation as it is called.

All accumulators, no matter whose make or what size, give 2 volts per cell. In reality they start to discharge at about 2¼ volts, soon falling off to 1.80.

The amperes, or quantity of current delivered, depends on the number or size of the plates—that is to say, on the amount of active surface exposed to the action of the solution.

Batteries of the Faure type used for tram lighting, traction and similar work, will be found usually to contain plates about 12" x 12" square. Where it is not convenient to ascertain the output allowed by the manufacturers they may be discharged at 3 amperes per positive plate. Thus a cell having 5 plates (3 negative and 2 positive) could be discharged without much danger at 6 amperes.

Another rule given by some is to weigh the elements, and discharge at a rate not exceeding 4 amperes per lb., all told.

When a battery of the Faure type is charging, the paste expands, and when discharging, contracts, as the lead grid, however, does not contract again after being expanded, care must be taken on charging for the first time not to force the battery, or when the paste contracts during discharge it will recede from the metal grid, and on first shaking up it receives will drop to the bottom and by degrees form a short circuit across the elements.

In regard to applying accumulators to traction purposes the chief difficulties (and they are not of minor importance) are, 1st, Buckling of plates, owing to the excessive discharge at times. For instance, a well filled car started on a grade will draw considerably more than the normal current usually taken by the motor; in fact even if a considerable allowance is previously made in battery supply for ordinary strains, yet it is almost impossible to allow for a case as above stated. We have only to look at our Montreal service on Bleury street to see whether I am citing an impossible case.

Buckling is caused by strains either by charging or discharging at too high a rate.

Again, the bumping which cars are subject to will cause the paste of Faure type batteries to fall out, and short circuit the plate at the bottom. In the batteries of Planté or "all lead" type, the film of peroxide will also become loosened, fall to the bottom and short circuit in same manner, although they will take more time to do so. I have been criticized by some of my friends for a remark that I made in the *Witness* at the time of the storage battery excitement here. I stated that "the cold would affect the cells," not "make them into blocks of ice," as the *Witness* put it.

The objection raised was that sulphuric acid would not freeze, and that was one of the constituents in the solution. This is true, but it is also a fact that, being of greater density than water, it will settle to the bottom and the water will freeze, and even the slightest skin of ice will affect the discharge of the cell. I quote here a sentence from Sil. P. Thompson in speaking of batteries in general: "If a cell be warm it yields a stronger current than when cold. This is chiefly due to the fact that liquids conduct *better when warm, the interior resistance being thereby reduced.* In another part of the same work, "Elementary Lessons on Electricity and Magnetism," the same author remarks: "Pure water will hardly conduct at all," etc., "Strong sulphuric acid is a bad conductor."

Now you can see for yourselves what apparently might result.

A very objectionable feature in accumulators running in connection with a private plant is that space is generally limited, and unless said space is well ventilated, the escaping hydrogen gas evolved during charge and discharge is obnoxious and also corrosive in its action on other metals and machinery in close proximity. When a battery is charged, the positive plates assume a red, and the negatives a slate color; gas is given off freely, and the solution effervesces; the solution will also assume a milky color.

A battery's life is prolonged by never allowing it to remain wholly idle—to keep a little current running through it when not in use is good practice. *Never* discharge a battery wholly, always have one quarter of its capacity in it.

The connections between cell and cell often give trouble by the corrosive *action of the acid spray (acid thrown up by the gas when charging).* Lead burning or welding of lug to lug has been found the most reliable manner of connecting. Mercury cup contacts are also used; this is only applicable where cells are stationary.

Much of the foregoing has been, I am afraid, to the detriment of the accumulator, but nothing exists with disadvantages which does not also have its advantages. In electroplating the accumulator makes an excellent battery, furnishing a high amperage of current at a low E.M.F. It is also a valuable adjunct, and ought to be used, in plants working direct current constant potential systems, either 2 or 3 wire. Cells may be placed in shunt across the mains, helping to steady the current and to help the dynamo out during the hours of heavy load. An automatic circuit breaker is included to break circuit with the mains in case the E.M.F. of the cells rises too much above the E.M.F. of the dynamo. It will be seen that a shunt machine is the better to charge with, as when the resistance and counter E.M.F. of the accumulators rise, more current is forced round the fields, exciting them more and consequently raising the machine's E.M.F.

Mr. Wm. Bracken states in the *Electrical Review* of Feb. 20th, 1892, that there were 50,000 accumulators in use in the U. S. I daresay this figure has been largely augmented since then, and would have been more so but for absurd patent litigation and for the faulty practice on this side of the water of not using accumulators of sufficient capacity.

In regard to calculation of cells required we will take a supposed case. It is required to run twenty 16 c.p. 100 volt lamps for 10 hours, we will assume we use Julien cell. The above calls for a discharge rate of 10 amperes, and for a capacity of 100 ampere hours. Then 11 S. type will fill the bill, as its maximum discharge rate is 13 amperes, and its capacity is 120 hours. We will therefore need 55 cells, that is 50+5 (10% allowed in practice extra). If either double the time or double the number of lamps was required, we would require another series of 55 similar cells and put this lot in multiple with the former, or else use a cell of double the capacity. The tramways of the Seine, Paris, have lately adopted storage batteries, but there the conditions are favorable in many ways, further the Accumulator Company keep the cells in order for a small percentage annually.

Now, I think, I have already taken up more of your time than I am justly entitled to. I will be happy to answer any questions in my power, also to have the members inspect sample plates, etc., catalogues and price lists of the different companies which lie on the table. Thanking you for your kind attention, gentlemen, I will now close this paper.

* Paper read before the Montreal Electric Club, Feb. 20th, 1893.

PERSONAL.

Mr. W. H. Brenner, the electrical engineer of the Montreal street railway, has returned from a visit to New York and Boston, where he had gone to inspect the local power houses in the interests of the Montreal Company. It is the intention of this company to erect a power house during the coming summer, which shall be second to none in point of equipment.

Mr. Thos. Worswick, one of the ablest and best known mechanical engineers in Canada, died in the city of Guelph a few days ago. Mr. Worswick was born in Preston, England 52 years ago, but had resided in this country for many years, having been engaged until 1886 in the manufacture of steam engines and boilers at Guelph. For three or four years prior to his death he did business in Toronto as a consulting engineer. His death was the result of a severe attack of pneumonia.

Montreal, at present, pays $124.10 a year for each arc light; Toronto pays $108.59 per light; Kingston, $81; Ottawa, $80; Chicago, $100; Quebec, $30.

THE DEFLECTION AND CONTROL OF GALVANOMETERS.

By E. Tremlett Carter.

The observation of the conditions of electrical stress which produce and limit the amount ot deflection in any measuring instrument is an interesting and profitable one; and it is proposed in this paper to make a short study of the sources of the energy which produces the deflection in magnetic and thermal galvanometers, whether for measuring current or voltage. It is well known that two forces are concerned in the deflection; one, the electrical or magnetic force of the quantity measured, which is caused by the coil or heated wire: and the other the controlling force, which is variously produced by magnetic, gravitational, or other elastic forces. In most instances the controlling force has to bring the pointer back to zero when the current ceases; but there is an exception to this rule in the Cardew voltmeter type, in which the deflection is *produced* by the controlling spring and *cancelled* by the contracting wire. In any case, however, there is some transfer of energy when the deflection is being produced or cancelled; and the source and destination of this energy form a very interesting enquiry. In an ideal instrument the whole of the energy which produces the deflection would be given back when the pointer returned to zero. But, in practice, owing to the perfect elasticity of the deflection—through friction—the energy is only partially restored. The frictional resistances are opposed both at the forward and at the return motion of the pointer, causing a waste of energy on each occasion.

The energy which is temporarily expended when the deflection is being made must not be confused with that constant expenditure which takes place the whole time the instrument is in circuit. The two have no necessary relationship. The mere C^2R energy does nothing useful—neither in a magnetic nor in a thermal instrument. It may at first sihht appear that the C_2R function does some useful work in a thermal galvanometer; that, in fact, it supplies the heat by means of which the deflection is produced. But this supposition would be erroneous. The energy which does the work of the deflection is actually put into the instrument when it is manufactured, namely, at the moment the tension of the controlling spring is brought to the required amount. The *resilience* of the spring is a continual store of energy which is partially and temporarily drawn upon whenever a deflection takes place. This is restored to the spring in full amount when the heated wire cools and contracts. If we trace the passage of this energy from the instant it leaves the spring to the instant it gets back again, we shall follow a thermodynamic study of peculiar beauty. It is well known that all substances which expand on the addition of heat have their specific heats apparently raised by being subjected to increased external pressure, and lowered by being placed under tensile stress. The reason is that in our former case the expanding body does external work against the compressive force, while in the latter case the stress expends some energy in heating the expanding body. On this account, if a thin wire is heated by the passage of an electric current it will take less energy from the current, and will take less time in rising to its limiting temperature if it is under tension than if it is slack. Some of the stored heat of the wire is due to the current, but some of it is due to the expenditure of resilient energy under the relaxation of elastic stress of the spring which holds the wire tight. When the current ceases and the deflection is returning to zero, the conditions are reversed. The contracting wire expends heat on the tension spring, restoring its lost resilient energy; and, in the ideal instrument, the amount of heat which will thus be converted into work will equal the energy originally taken from the spring. Thus it will be seen that the true C^2R function has nothing to do with the source of energy which causes the deflection. If the stress-strain diagram of the hot wire of such an ideal instrument be plotted, the curves representing a complete cycle will inclose no area; but in an ordinary instrument this would not be the case. In such the curve of deflection would lie nearer to the axis of stress than the curve of restoration to zero; and the area enclosed would represent loss of energy on account of friction, pretty much as the area of Ewing-cycle represents hysteresis losses.

In an electro-magnetic galvanometer the source of energy of the deflection is the electric circuit, but not through the medium of the dissipation function. The medium of exchange of energy is an electromotive force which is set up in the circuit when the needle moves. In a forward deflection there is a back electromotive force, which takes some energy from the circuit: while in the return of the deflection to zero there is a helping or forward electromotive force which restores this energy to the circuit from whence it had been taken. During the deflection this energy exists potentially in the controlling mechanism. Thus, if there is a bar-magnet control the energy is stored magnetically in the ether; if there is a spring control, the energy exists as resilience of the spring; while if there is gravity control, the energy exists as a stress—*where*? Would that we could say where! *Is* it the ether?—*The Electrician.*

McGILL UNIVERSITY ENGINEERING LABORATORIES.

By W. B. Shaw.

The formal opening of the McGill engineering buildings took place on Feb. 24th, under the patronage of the Governor-General. In the evening a conversazione was held, which was well attended. The writer took the opportunity, as far as was practicable, of looking over the electrical plant, which consists of the following:

The dynamo room on the ground floor contains two 30 Kilowatt dynamos, delivering current to the lamps at 100 volts. One dynamo is of the Edison-Hopkinson (English) type, and is direct coupled to a Willans upright compound engine running at 400 revs. The other machine is from Siemens Bros. & Co., London, Eng., coupled direct to a similar engine running at the same speed. These two machines bear the brunt of the work at present.

The building is wired throughout on the three wire principle, and so arranged that one dynamo only may be used when required.

The main switch board is built on wood panelling, and contains many kinds of switches, double and single pole, transfer, etc., of both English and United States manufacture, all being on slate bases. Crocker-Wheeler rheostats and Weston instruments are prominent upon it. The circuit from the Crompton-Howell accumulators, located in a room upstairs, is also brought to the main switch board.

The accumulators are themselves charged from a small Crocker-Wheeler generator, specially for the purpose, driven by a motor of the same type. An independent switch board of smaller dimensions, but constructed in the same manner as the main one, with Nalder Bros.' instruments, automatic break switch, etc., is situated near the charging generator. All wires run from the main switch board to a distributing board, where the different circuits throughout the building are branched off. Other machines have been placed in position, but have not yet been allotted their respective loads:—Two No. 4 Edison generators, one No. 8 Edison generator, presented by the Canadian General Electric Co.; one T. H. arc dynamo, presented by the Royal Electric Co.; one motor type direct current dynamo, 200 light, presented by the T. H. Electric Co., Lynn, Mass., also several English machines of various types.

A special feature in this room is the electro-magnetic shaft clutch designed by Prof. Caius-Wilson. Circumstances, however, did not allow of a test being made as to the amount of current required by them. Small Carpenter enamel rheostats are used in conjunction with the clutch arrangement. The foundry is lit by Ward arc lamps.

The electrical laboratory upstairs is complete with test instruments, among which are Aaron electricity meters, Shallenberger alternate current meters, Elliott's testing sets and Wheatstone bridge, Nalder Bros.' volt and ammeter, also Weston's, etc., etc. The magnetic laboratory and temporary photo-meter room is situated on the floor above this again. The passenger elevator is operated by an Edison motor, and different sizes of Crocker-Wheeler motors are used throughout the different workshops in the building.

The physics building is also lit from the engineering building plant, at 95 volts, an equalizing coil being used in this circuit.

Prof. Cox's laboratory, containing many valuable physical instruments, is in the building. A large Wimshurst influence machine, Rhumkoff coil, sets of Geissler tubes, etc., are to be seen in the Professor's collection.

With such a plant at hand it will be strange if some prominent electricians are not produced from McGill in the near future.

NOTES.

G. H. Evans, of St. John, N. B., has been granted a patent for a steam engine governor, and T. W. Mount, of the same city a patent for a steam engine load regulator.

Messrs. A. M. Wickens and John A. Wills have been appointed representatives of the Canadian Association of Stationary Engineers on the Board of Management of the Toronto Technical School.

Mr. J. G. Campbell recently gave a very interesting illustrated lecture before the members of the Stationary Engineers' Association of Kingston, on dynamos, motors and the various systems of electric lighting.

The Association of Stationary Engineers, of Kingston, will apply to the local legislature at its next session for legislation which will make compulsory the examination and granting of certificates to all who take charge of steam boilers.

At slow speed a heavy leather belt takes the power of the motor to the machine. As speed increases, the same equivalent of power is conveyed by a slighter pull, and Sir Robert Ball shows that a belt as light as sewing cotton, running at the speed of a rifle bullet, will carry a horse power; while if it were possible to run a belt of the lightest line known—the spider's web—with the velocity of light, it would carry something like 250 horse power.—*Invention.*

In view of the prevailing impression that the compound engine is unsuited for varying loads, it is interesting to notice that in a test of the comparative variation in economy with change of load in simple and compound engines, reported at a recent meeting of the American Society of Mechanical Engineers, Professor Carpenter found that for a given variation from rated capacity the compound was less affected than the simple engine, while Professor Peabody reported at the same meeting, test of a triple expansion engine showing a variation of fifty per cent from a very light to an average load, with a variation in efficiency of but nine per cent.—*Power.*

One of the most common abuses to which boilers are subjected is the introduction of feed water at the bottom of the boiler. You ask, "why?" Feed water, unless a heater is attached, is usually of low temperature, and often cold. Water is no exception to the law that compels heated bodies to rise—for so being expanded—is lighter, and the cold water, obeying the law of gravity, instead of rising and mingling with the heated water above it, maintains its level and flows along the bottom of the boiler till its temperature is equal to the rest when it rises to make room for colder. The effect of the cold water is to suddenly contract that portion of the boiler with which it is in contact and thus weaken the rivets and plates, and ultimately, cause them to give way. The effect is not always noticeable at first—often requiring years to do its work, but again, the contraction is sometimes so marked that the bottom seams will leak as soon as the pump is started and stop when taken off—the only thing to prevent a rupture being the toughness of the rivet and shell. If a practical demonstration of the effect of contraction is desired, pour cold water in a red hot kettle. Feeding water at the side, although not so injurious as at the bottom, is reprehensible. Some of the foremost builders allow it to be introduced at the top only, and before it can settle to the bottom it is thoroughly heated and no contraction of the shell follows.

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NOTES.

In the matter of inventions it is a curious fact, says the New York *World*, that Professor Bell's latest device of importance, the "waterphone," for locating leaks in water pipes, was suggested to him by observing a plumber's apprentice endeavoring to find a leak by means of a small steel rod which he held in his mouth and touched against the pipe.

An excellent method of cooling hot bearings is said to be to keep in a handy place a pint bottle of ammonia, and when the box gets so hot it is liable to fuse the metal, pour the ammonia in quite liberally, but not extravagantly, and then follow it up with a free use of good oil. In case bearings are adjusted too close, slightly loosen the bolts holding down the cap, when there will be no necessity for shutting down the engine.

The maintenance of a constant water level in a boiler conduces to economy in fuel and repairs as well as providing dry steam at all times, owing to the possibility of carrying, without danger, a lower level of water, thus insuring dry steam, and by the use of dry steam it is well known that more power can be developed from a given quantity of water evaporated, and less lubricant will be required for reducing the friction of the working parts in steam chest and cylinder. — *Wood Worker.*

A French engineer has invented a new crank, which he claims does away with the dead point. The crank-pin works in a slot cut in a steel disc fastened to the end of the shaft, and is pressed upon by a spring, which is so adjusted that, at the ordinary working steam pressure, it is held firmly in place. If, however, the crank be at a dead point, when the full pressure of the steam is admitted into the cylinder the spring is compressed, the crank-pin slides in the groove so as to assume an angular position to the shaft, and the latter begins to revolve. As the pressure of the steam in the cylinder while the engine is in motion is less than that in the boiler itself, as soon as the shaft begins to turn, the pressure against the spring is relieved, and the crank-pin flies back to its usual position. The tension of the spring is adjusted as necessary.

A correspondent of the Boston *Journal of Commerce* writes: "We have in use, among others, an eight inch belt running off a high-speed engine governor pulley, which has caused no end of trouble. It has run five or six years, and has by degrees become almost saturated with oil. Although washed several times the second night after washing it was ready for another treatment, as the washing did not take out the oil. As an experiment we tried chalk. The effect was instantaneous. By holding a good-sized piece of the aforesaid article against the belt while in motion, after awhile using a scraper and scraping it off, then applying the chalk again, and repeating the operation every hour, we found the desired effect was produced, putting an end to the trouble. It is the best thing I ever saw used on a belt that cannot be taken off and put through a process to extract all the oil and grease."

NOTES.

Recent experiments have been made with ramie fibre as a substance for making steam pipes. The material is subjected to tremendous hydraulic pressure, and being unaffected by moisture, will neither shrink nor swell, besides being a non-conductor of heat. These pipes are said to have twice the tensile strength of steel pipes.

TIGHTENERS. – Tighteners are mostly required in cases where belts are running on pulleys largely differing in size. They should be run near to the smaller pulley, whether it be the driver or driven, provided, of course, it is practicable to do so. There may be cases where the tightener cannot be applied close to the small pulley. The object of having the tightening pulley closest to the smallest of the two pulleys, is to use it for the purpose of increasing the lap of the belt on the pulley.

In considering the matter of the value of a coal for boiler purposes, says the Boston *Journal of Commerce*, the rate of combustion of the coal is too often overlooked by the careless engineer, who, glancing at what appears to be a hot fire, immediately concludes that is all there is to be desired. The reason why so much bituminous coal is used where a mixture with other coals might be economical, is because of the slow rate of combustion of the poorer fuel. It is not possible to get as much power from a boiler with hard coal as soft, and the harder the coal is and more difficult to burn the less will the power of a given boiler be. An engine must have the steam, and if a slow-burning coal is to be used, no matter how hot a fire is obtained, extra boiler power must be provided because the boilers are less efficient as steam producers. If a coal is twice as hard to burn, twice the boiler capacity will be required to supply steam, and this requires the outlay of an extra large plant and its maintenance, and in the most of our mills the preference is not to extend the size of the plant, hence the large use of bituminous coal. Mr. Barrus found that the labor and coal to produce 1000 horse power in a day was much less with a mixture of pea and dust and culm, and that Nova Scotia culm would produce 1000 horse power at a less cost than Cumberland, but the greater amount of steam produced by the boilers using the Cumberland coal was an advantage that the cheapness of the other coals could not overbalance. The harder a coal is to burn the less its adaptability for boiler uses from a practical standpoint. This is one thing the Nova Scotia coal must compete against.

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