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THE CANADIAN ENGINEERING NEWS.

A Monthly Journal

DEVOTED TO EVERY BRANCH OF ENGINEERING.

EDITED BY W. E. GOWER, C. E.

VOL. I.—No. 2. MONTREAL, FEBRUARY 28, 1893. $1.00 PER ANNUM. SINGLE COPIES, 10 CENTS.

CANADIAN ENGINEERING NEWS,

PUBLISHED AND EDITED BY W. E. GOWER, C. E.

204 ST. JAMES STREET,

Montreal, March, 1893.

Dear Sir,

We herewith send you a copy of the second number of the Canadian Engineering News. As this is the only publication in Canada representing the general engineering profession and trades, I trust you will see your way to become one of my regular subscribers and would ask you to fill in the annexed form.

Yours truly,

W. E. GOWER,

PUBLISHER & EDITOR.

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THE

CANADIAN ENGINEERING NEWS.

Published on the last day of each month at Montreal.

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The reception of our first number by the the profession and trades of the different classes of Engineering has been most gratifying, and we beg to thank those who have so kindly written us their words of encouragement and good wishes. We trust that we shall continue to merit the approval so generously accorded.

The past week or so will in a sense become historic in the annals of Engineering in Canada, and Montreal especially. The gathering of the members of the American Institute of Mining Engineers, the mining engineers of Nova Scotia, Ontario and Quebec Associations. The annual meeting of the Canadian Society of Civil Engineers, the annual gathering of the Stationary Engineers, and finally, the opening of the Engineering and Physics' building of McGill College, made it a week of combined pleasure and real labour to most engineers within a day's journey of the scene of all these functions.

The remarkable interest taken in the now justly celebrated College was evinced by the thousands of ladies and gentlemen who attended the opening ceremonies and the *conversazione* in the evening. To describe the complete and compact appliances and machinery that fill the vast labratories and shops will take us many issues, our report therefore of the opening scenes will only give a faint idea of the wonderful equipment of the various branches.

The members of the various mining associations cannot but carry back with them a higher estimate of our country and the wealth of intellect that is being awakened in our midst, and the chances that there are of developing it at our doors through the munificence of Mr. McDonald.

Naturally a great many of the papers read before the convention related to mining, but some few mechanical papers were given, some of which will be published in our next number. We think it to the credit of the Dominion that the papers read by the Canadian section compared very favorably with those of the parent section from the United States in research and practical views, this is especially the case in the Engineering section, Mr. Burchell's paper on Electric Mining *versus* Compressed Air, being a very able and practical paper which will be reproduced in our next issue.

The Canadian Society of Civil Engineers are to be congratulated on getting for their transactions such an able paper on Compressed Air, by Professor Nicholson, an abstract of which of some length is given on another page, the possibilities of this motive power, as so clearly given in this paper, will be a revelation to most engineers in this country, and we feel sure its dissemination, even in a condensed form, in our columns will lead to further and full experiments at an early date by some of our engineers at home where water power is so abundant compared with European and even American centres of manufacture.

The kindly interest always shown by Lord Stanley in the Canadian Society of Civil Engineers was remarked by the fact of his attending the ordinary meeting of the Society (of which he is a Hon. member), at which Prof. Nicholson's paper was read, and the pleasure he expressed at being present.

The question of forming the Canadian Society of Civil Engineers into a close corporation is a matter that has been mooted, and after Mr. Alan Macdougall's plea we would ask for the views of the profession, both members and non-members of the society. It is a matter of the greatest importance to those now engaged in the profession and also to those coming after us. It is conceded that the close corporation of Surveyors of Quebec is not what we would wish to see extended, and it is doubtful even in law and with a hard and fast charter whether the Canadian Society of Civil Engineers for the non-payment of dues on the part of a member, through neglect or misfortune, could force a once admittted civil engineer to abandon his profession in his own country by striking him off the register and refusing to allow him to consult or practice, or call himself a C.E.

The report of the annual gathering of the Montreal Branch of the Stationary Engineers which we give elsewhere, will convince every one allied to this branch what admirable work this society is doing throughout Canada, and when it is known that this is not a labour organization, in the generally received sense, but a society formed for mutual help and improvement, for the reading and discussion of papers and diffusion of knowledge pertaining to their business, we say that such society should have the approval of both the higher grades of the profession and all employers of mechanical skill. The time, we trust, will soon come when the members of the various branches of this society will have the first chance of filling any places of trust, and we even go so far as to say that we hope the time will come when none but members of the society shall have the care of engines and boilers entrusted to them.

The columns of this paper are open to the discussion of all subjects relating to Civil, Railway, Hydraulic, Sanitary, Mechanical and Stationary Engineering, also to water works, water supply, street lighting and paving, gas supply, &c. Practical information upon these subjects with photos and tracings which may be used for illustration are especially desired. We shall also be glad to receive brief notices as to improvements or works in progress or contemplated.

We feel sure that most of our readers will carefully scan our advertising columns and we solicit from Manufacturers, Machinists, Importers, Merchants, Water and Gas Companies and Corporations, correspondence as to rates.

TRANSMISSION AND DISTRIBUTION OF POWER BY COMPRESSED AIR.

BY JOHN T. NICHOLSON, B. SC., M. CAN. SOC. C. E.

(Abstract of paper read before the C. S. C. E.)

The intention of this communication on the subject of the transmission and distribution of power by means of compressed air is mainly twofold. In the first place, to lay before this Society the fact, which has now been plainly proved by the experiments on the Paris installation, that the utilisation of energy by means of air under pressure is a more economical, convenient, and secure method than any other yet known. Secondly, and as a consequence of this statement, to present a précis of the theory of the whole subject as founded on recent experimental results, so that the necessary data may not be wholly lacking from the records of this Society, when its members are called upon (as it is the author's belief that they shortly will be) to enter upon this department of engineering work.

Reference must be made incidently to the importance (from the politico-economical point of view) of the encouragement of small industries in great manufacturing centres; and an attempt will be made to estimate the commercial feasibility of a scheme to supply and distribute power by air compression in Montreal; where, unlike Paris, competition with electrictity as an energy-transformer may be expected to be very severe.

Until quite recently it has been supposed that energy transmission by the agency of air is of necessity an extremely wasteful process, the idea of its ever being able to compete with electricity for instance having hardly entered anyone's thoughts. This widespread notion has now, however, been traced to its true source, by the eminent engineer, Professor Riedler of Berlin, and its erroneus nature completely demonstrated by the valuable and extensive experiments made by him and Professor Gutermuth on the 5,000 H.P. plant now at work in Paris. In illustration of the kind of evidence on the strength of which such views are commonly held on this subject, we may refer to Riedler's treatise on "New Experiences with the Power Supply of Paris by Compressed Air," where on page 37 it is stated that the usual efficiency of small mining plants is 10 per cent. to 15 per cent.; and that even with such compressors as those used at the St. Gothard Tunnel and by Sturgeon in Birmingham, three-fourths of the power is lost before the air reaches the mains even. And yet the feasibility of the economical transmission of power by compressed air has been criticised by the results of such inherently bad installations as these. It is as if the efficiency of the steam engine were to be jndged by considering the economical value of one using forty or fifty instead of fourteen or fifteen lbs. of water per H.P. per hour. Is it not, on the other hand, altogether surprising that with the common occurrence of such extremely bad results, the system should have in any case survived? Had it not been for the inherent vitality and power of this method it must certainly have perished under such ill usage.

The recent adoption of the two great improvements of compression by stages and the use of a preheater before expansion have enabled Riedler to state definitely as to the results of his experiments, that with even the ill made motors used in the small industries in Paris an efficiency of 50 per cent. is obtained, and with the old steam engines of larger power which are commonly used, 80 per cent. of the work of compression at the central station is developed in the motor; and that it is actually possible by using all the latest improvements in compressors and motors and with a very insignificant expenditure of fuel in the preheater easily to obtain just as much work at the motor as is supplied at the distant compressors, or in other words to have a practical working efficiency of 100 per cent.

Such a result as this is quite unattainable by any other mode of power transmission; and is due simply to to the fact that on this system alone is it possible to insert a charge of energy at the working point with no sacrifice to convenience and at an almost insensible cost.

Without further comment or comparison at present, let us pass on to investigate the theory of this surprising (practical) result.

The system of compressor air main preheater and motor is diagramatically represented in Fig. 1 where *a* is the compressor driven either

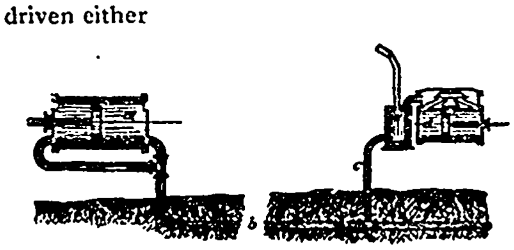


Fig. 1

by steam or water power; *b* is the air main leading from the central power generating station to the distributing mains; *c* represents a branch main taken off to run a motor *d*, and which, before supplying air to the motor, passes through a small heating stove or preheater *e*.

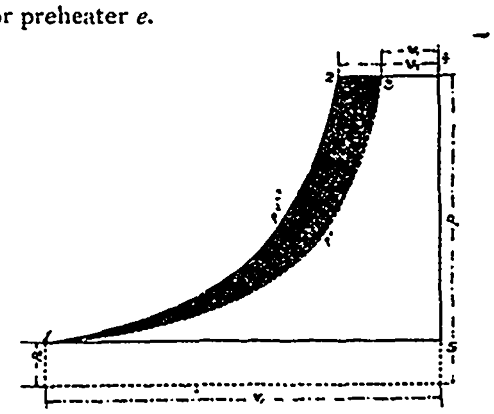


Fig. 2

COMPRESSORS.

Considering the action of the compressors first; figure 2 is a diagram supposed to have been taken from air compressor *a* and given for the purpose of comparing the amounts of work done when one pound of air is compressed adiabatically and also isothermally.

If no heat be removed from the air during compression, it expands along the curve 1 2, whose equation is $p v^r$ = constant and the work done is

$$\frac{p v^1 - p_0 v_0}{r-1}$$

this is spent in increasing the intrinsic energy of the air; the temperature rises from T_0 to

$$T = T_0 \left(\frac{p}{p_0}\right)^{\frac{r-1}{r}} \quad \ldots\ldots\ldots\ldots(1)$$

where p v_a T and p_o v_o T_o are the pressures, volumes and absolute temperatures of the air at the points 1 and 2 respectively.

The most successful way of preventing the accumulation of heat in the compressors is to do the work in two (or more) stages. This is accomplished by allowing the air after its pressure has risen a certain amount to flow through an intermediate receiver of sufficient capacity to cool it almost down to the temperature of the atmosphere, so that when drawn into and compressed to the final amount in a second or high pressure cylinder its state is again represented by a point on the isothermal or atmospheric temperature.

LOSSES IN THE MAIN FROM LEAKAGE AND FRICTION.

The general opinion has hitherto been that long distance power transmission by compressed air involves of necessity great losses from leakage and fluid friction in the mains. This view can, however, no longer be held in the face of the experimental results obtained with the Paris supply pipes. The tests carried out there by Gutermuth and Reidler are the most exhaustive and on the largest scale ever attempted. By permission of the authorities in the French Capital, trials for leakage and friction were conducted and repeated with lengths of pipes varying from two to ten miles, the diameter being about one foot.

The amount of leakage from the mains was determined by allowing them to stand under pressure, and observing the amount of fall on the guages as time went on. As the mean result of several experiments it appeared that 2,330 cubic feet of air at atmospheric pressure were lost by leakage per mile per hour. This amounts to 8 per cent., as the main was one foot in diameter and the pressure 7 atmospheres absolute; so that the pressure fell to 6.44 atmospheres at the end of the hour. If the velocity of the air be increased from 1.46, at which rate it would have moved to pass a mile of pipe in one hour, to 30 feet per second, its usual velocity! then the air, instead of being one hour, would only remain 3 minutes in the mile of main, and the loss is reduced to 0.41 pounds per square inch per mile.

This surprisingly good result is an evidence of the extremely efficient joints fitted on the Paris pipes. These pipes are of cast iron with plain ends, and are jointed by means of three cast iron rings and four bolts acting on two elastic packing rings.

Better results even than these can certainly be obtained with new mains equally well laid, for the results given by Reidler include several unknown losses such as the pneumatic clock system supply, and that to some small motors that could not be stopped.

Previously to the large scale and careful work of Gutermuth and Reidler, the only experiments on the subject of loss of pressure by friction of air flowing in long pipes were those of Arson (v. P.I.C.E. Vol. 63), of Devillez on pipes up to 5 inches diameter, and of Stockalper on the 6 and 7½ inch pipes supplying the drills in the St. Gothard Tunnel.

Taking these older results and those obtained at Paris together it appears that they agree fairly well, provided the co-efficient of triction be supposed to diminish as the size ot the pipe increases. Unwin has discussed in four papers (Vol. 43, 63, 93, and 105) in the Proceedings of the Institution of Civil Engineers the question of the loss due to firiction of air flowing in long pipes.

MOTORS.

The air having now arrived at the motors may be allowed to expand adiabatically, *i.e.*, without addition of heat, or it may be warmed during expansion by a spray injection; or again it may be worked in two stages and warmed in an intermediate receiver of sufficient capacity. The best mode of using the air, however, is to pass it through a heating stove or preheater, and begin expansion in the motors with air at as high a temperature as is convenient, the expansion afterward taking place along the adiabatic curve. If the motor be large enough to warrant the necessary primary outlay, it should indeed be heated twice; being delivered by the high pressure cylinder at a pressure of two or three atmospheres, again passed through a heater and expanded in a large cylinder until its pressure falls to that of the atmosphere.

Without pre-heating, one-horse power in the distant steam engine was found to give 0.61 horse power on the motor brake. With pre-heating to 400 F. we get 1.0 horse power. Hence we get 0.39 horse power by an additional expenditure of 0.3 pounds of coal or

$$\frac{.3}{.39} = 0.78$$ pounds of coal per horse power per hour.

It will be remembered that it was found advantageous in the compressor to keep down the temperature by abstracting heat during compression, which is delivered to natural reservoirs such as water and air at atmospheric temperature. Similarly we see that in the motor the most economical mode of doing work is to keep up to the isothermal cuive as much as possible by adding heat during expansion from these same natural sources, water and the atmosphere, either by injecting a spray or by using an interwarmer at atmospheric temperature.

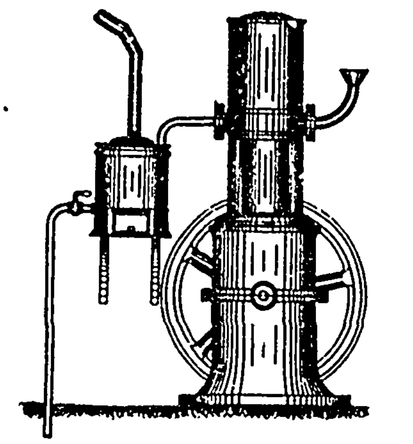
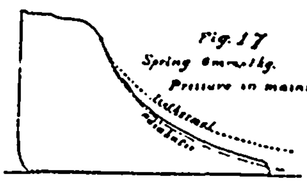


Fig. 16.

1 H.P. MOTOR



It has long been the custom in Paris to use a small stove through which the compressed air is passed before being used in the motors; such an arrangement is shown for a one-horse motor to a scale of one inch to the foot, in Fig. 16, and an indicator card from the same in Fig. 17. It now appears that heat transmitted into air under pressure extraordinarily efficient. It is almost wholly converted into mechanical effect. This would lead us to consider the highly interesting question of the theory of the pre-heater. The author prefers, however, to withhold this for the present, pending the completion of some experiments now being made on the subject at McGill College, by which he hopes to be enabled to fill in the necessary constants in the expressions obtained for the heat transferred into the fluid under given conditions of heating surface, temperature difference, velocity, and dryness of the air. Suffice it for the present to give the following practically realized data for a motor of one brake horse power:—the air can be heated from 60° up to 400° F., with a stove whose external dimensions are 8" diameter and 12" high at an expenditure of 0.44 pounds of coke screenings per hour; while for a motor of 40 horse power the pre-heater need only be 16" diameter and 28" high, and will require only 0.22 pounds of fuel per horse power per hour.

The possibility of the subsequent addition of energy at such an insignificant cost is a special characteristic of this system of energy transmission Such a supplementing charge can indeed only be administered when compressed air is the working fluid; and by this means not only can the heat uselessly produced at the generating station and lost in the mains be made good; but, as has just been shown, more heat may be added than was originally lost, and the motor may at a very small expense, and without any additional trouble or inconvenience, give out more power than was spent on the compressor.

In reference to this point it may be stated that the air motors and pre-heaters in Paris are attended to, -perhaps more correctly stated are left unattended,—by waiters and domestic servants who have all manner of other employments. All they have to do is to turn on the air-cock, refill the lubricators, and put on a shovelful of fuel once or twice a day. As Prof. Ridler has remarked, the air motor appears to be even a more long suffering machine than the steam engine, which is so deservedly celebrated in this respect. With regard to the amount of preheating to be resorted to, this depends on the size of motor and the desired temperature of exhaust. If the motor is a large and powerful one it may be advisable to use two heaters, both a preheater and an interheater. For motors of 10 horse power and under, however, one will usually be sufficient. If the air enters without preheating it will be exhausted at temperatures from 10 to 25° F., in which state it may be used for cold storage or other similar purposes. This is largely the case in Paris, where in many restaurants and cafés, air motors drive the dynamos for lighting, and the escaping cold air is afterwards led into refrigerators for obvious purposes. Confectioners again use the motor during the day to drive the mixing and other machines, light their shops in the evening, and use the exhaust for making ice. The exhausting of clean cold air into a workshop is a great advantage in a hot climate. If, on the other hand, recourse is had to a considerable amount of preheating, the air will be exhausted at or even above atmospheric temperature; and with a large motor, enough warm fresh air may be obtained to serve in winter for heating and ventilation.

In entering upon the consideration of the commercial feasibility of a transmission and distribution schemeby compressed air, let us direct our attention to a concrete case, and postulate the conditions which obtain in the locality in question as regards cost of coal, nature and amount of available water and other power.

Referring, for example, to Montreal, let us take for granted that an abundant supply of water with a fall of, say 20 feet, can be obtained 5 miles from the city ; and that all difficulties in connection with the utilization of this power, such as frazil can be, as the author believes they can be, successfully overcome. This being the case, let us in the first place consider whether power can be supplied on a large scale to a mill-owner at anything like the same price as he can make it for himself by burning coal in steam boilers, and using the steam in a first-class steam engine.

First then let us consider at what price per horse power per annum a pneumatic power supply company, owning its water supply, can afford to deliver to a consumer 5 miles away, compressed air at a pressure of, say, 95 lbs. on the gauges.

From statistics and data given by Swain, Manning and Main, it appears that the cost of one H. P. on the wheel shaft, that is for dam, head and tail races, turbines and shaft, penstocks, gates and wheel pit, for a 2,000 H. P. plant, varies from $17 with a fifty foot head, 100 foot distance from supply to discharge, to $153 with a ten foot head and a distance of 600 feet.

In the case of the works now approaching completion at Austin, Texas, the figure, as kindly supplied me by Mr. Lea, of McGill College, is $14 for an average head of 57 ft. and a distance from canal to river of 600 feet.

In the present case it has been assumed that the cost of one wheel H.P. is $90; which will allow, with a head of 20 feet, a distance from supply to discharge of about 700 feet, or, with a head of only 10 feet, a distance from river to canal of 100 feet.

It will probably be admitted that this is a somewhat high estimate for this location, where the average head may be expected to be from 20 to 30 feet, and the possibility of dispensing with a dam will allow for almost any reasonable length of supply and discharge canals. The fixed expenses on this capital sum are here taken at interest 5 per cent., repairs 1 per cent., depreciation, etc., 2 per cent., or a total of 8 per cent., which on $90 amounts to $7.20. The running expenses, including attendance, oil and waste, are taken at $0,75 per H.P., making a total annual expense per H. P., supplied at the turbine shaft of $7.95.

The compressors will cost considerably less than a steam engine of equal power; for although they cannot be said to be now in the market in this country (the highest type of modern first-class compressor being here in question), yet this will be more than compensated for by the lack of air and circulating pumps, and the fact of there being no crank shaft to charge against the compressor, this having been already reckoned along with the cost of the turbines. The cost price of compressors may therefore be taken at $10 per gross H.P., and if we take the fixed expenses at: interest 5 per cent., depreciation 4 per cent., repairs 2 per cent., together 11 per cent., and the running expenses at 75 cts. per H.P.., the total cost per H.P. per annum of compressors is $1.85.

The twelve inch cast iron mains with special flexible joints, as used in Paris, may be expected to cost $30 per ton; which is at the rate of $1 per running foot. Adding 25 cts. per foot for trenching and laying, we obtain a total of $33,100, or $16.55 per H.P., for 5 miles of 12 inch main. Taking interest 5 per cent., depreciation 3 per cent., repairs ½ per cent., together 8½ per cent., the cost per H.P. per annum amounts to $1.40.

The total annual expenditure of mill owner for power supplied by water and air is as follows:—

Cost of air supply	$17.03
Air Motors	4.01
Extra heating	2.80
Grand total of	$23.84

Which insures 10% profit to Power Supply Co., and 5% interest on plant to himself.

With this we have now to compare the cost to him of steam engine and boilers of the same power, for which the total expense incurred by the mill owner for the production of power by steam is therefore as follows:—

Fixed Expenses	Boilers	$3 50
	Boiler house and Chimney	0 60
	Engines	1 40
	Engine house	0 50
Running Expenses	Coal	11 35
	Oil and waste	0 80
	Attendance	2 46
		$20 61

per horse power per annum.

The cost of a horse power supplied by means of water and air was found to be $23.84, hence we see that so long as coal remains so abundant and cheap, and can be so cheaply transported by land and sea, other natural sources of energy will continue to be of an inferior value. The great transmitters of energy are indeed our railways and steamships, which transport at a rate infinitely cheaper than by any other means the enormous stores of mechanical energy accumulated in our coal fields; and that in any required amounts and to any distances, unhampered by the losses of power which inevitably accomplish every transformation.

The only chance for a commercially successful utilisation of water power in a neighbourhood well situated for coal supply is a case where the capital outlay for water plant can be reduced considerably below $90.00. As, for instance, by the accident of great head; such natural fitness that the supply and discharge canals may be short, or that a dam is not necessary. Then and then only can power be supplied to a distant mill by means of compressed air at a price which competes with the cost of production by steam at the mill or factory itself. If, for example, we take the capital outlay at $20.00 instead of $90.00 for power delivered by the turbine shaft, then the annual cost to the mill owner of his air supply, air motors, and steam heating plant on the same scale as before is reduced to $15.34, or about two-thirds of its former estimated cost, one fourth less than the calculated cost of steam. It remains for experts on water utilisation in this district to examine whether a source of water power supply cannot be found, such that the initial outlay per horse power delivered to the compressors need not be more than $60.00; in which case, power can certainly be supplied on the pneumatic system at a cost less than that of steam even to a large factory working full time.

Any other system of transmission, wasting as it must at least 25 per cent. of the energy supplied at the wheel shaft, at once raises the cost per horse power from our supposed $15.34 (when the capital outlay for water power is $20,00) to $20.45, or the same as that of steam.

Considering the case of an employer using a small amount of power, we find that the total cost of one H.P. amounts to

Air	$33 33
Fixed charges	3 30
Running expenses	1 10
	$37 73

37.75. This assumes that he works at full power for 10 hours a day during 308 days. If he works only at ½ power, this price will be reduced almost in proportion to the smaller power employed, as the air motors cut off automatically; and if he work intermittently, it will be reduced in the same manner, as he is only charged for the air which actually passes through his meter. For example, if his 10 brake horse power motor works 10 hours a day, his power bill will be $377 per annum. If he runs only five hours a day, the amount sinks to $210; and smaller quantities in the same proportion meted out with the precision of an ordinary gas meter. This estimate is based on an assumed necessary expenditure of $90.00 for water and wheel plant. The author believes this to be a very high price for Montreal.

The cost of a horse power varies in Montreal from $60 to $120, rented to or supplied by consumers using from 3 to 25 horse power; so that on the lowest estimate these would save from $22 to $39 according to amount used, per horse power per annum, by a system of compressed air distribution.

Lastly let us inquire what can be done by generating power in a Central Station near the city, by means of first class triple expansion steam engines and first-class compressors; and distributing the same to customers in a main of a length of two miles for each 2,000 horse power.

Without troubling the Society with details, the schedule of annual charges will run somewhat thus:—

Fixed expenses,	Boilers	$3 50
	Boiler and Engine houses and chimney	1 20
	Triple Expansion steam engines	2 23
	Compressors	1 10
	Mains (12" dia.)	0 56
Running expenses,	Coal	8 28
	Oil, waste, etc	1 00
	Attenaance	2 46
		$20 33

The total cost to the Central Station Coy. of one compressor horse power is thus $20.33 which includes 5 per cent. interest on their expended capital of $71.37 per horse power. Allowing 5 per cent. more on this or 3.57 we have a total of $23.90 which is the price at which the C.S. Coy. can supply air to consumers.

The easy inference from this is that 500 consumers in this city, of an average of four horse power each, would, by forming themselves into a Central Power Supply Company, reduce their power bill by from 45 per cent. to 75 per cent.! It ought to be mentioned that the lower limit of saving just mentioned, assumes that the consumers' steam engines, which, without alteration, will serve equally as air motors, have a present value of $33.00 per horse power.

Regarding the question of heating in winter, there seems every possibility, in view of the successful system of steam distribution in New York, of being able to supply heat by laying mains to the city from the Central Power Station, and leading the exhaust from the steam engines in the same to be delivered to the workshops and houses in turn; and this at an enormous saving of fuel and expense to all concerned.

Reference ought here to be made to many advantages apart from the question of cost which attend the adoption of the pneumatic system of power supply.

In the first rank we may place the elimination of 95 per cent. of the smoke which now renders manufacturing centres so obnoxious from an æsthetic point of view, and of the dangers and responsibility attending the use of steam boilers by unskilled persons, these being done away with or removed from the more crowded parts of the city. The possibility of running air motors in the centre of the city, where a supply of water for condensing or even feed is extremely expensive, is an obvious advantage.

The extreme handiness of the working medium and its suitability for use by technically unskilled attendants has already been adverted to. In this respect the air motor bears away the palm from the electric motor, the gas engine, and even the much enduring steam engine; all of which require a certain modicum of knowledge or experience. The repairs also of such a machine require only a knowledge of perfectly well understood mechanical details.

The use of the exhaust for either refrigeration, ventilation, or even heating renders the rejected air a beneficial by-product, instead of a nuisance, as the exhaust from a steam engine certainly is in summer.

The suitability of compressed air for the working of lifts ought not to escape mention; a cheapening of the first cost of at least 10 per cent. and of running expenses at the rate of 75 per cent. over other systems can be easily attained.

Tram cars worked by compressed air are now in use in Nantes, Brussels, Chester, and other places; they have there proved both serviceable and economical in spite of the fact that the power they use is generated in small compressing stations. A reservoir capacity with air at a perfectly safe pressure can be obtained with an ordinary sized car to do a return journey of 5 miles without any intermediate charging station; and the consequent removal of a dangerous overhead wire, such as is used on the electric trolley system, is not to be despised in a populous city such as this. The difficuly of snow could be overcome by having a car devoted to cleaning the tracks alone; but this will be preferably effected by having a light overhead railroad, as the ruts in the streets caused by keeping a clean tramroad in winter are extremely unpleasant, not to say dangerous, to occupants of vehicles.

The convenience with which compressed air as a working agent could replace steam in a city already supplied with power by a number of small steam engines is sufficiently indicated when it is stated that all that is necessary to be done, without altering the engine in the slightest degree, is to uncouple it from the boiler and connect to the air main in the street with the interposition of a reducing valve and an air meter. The steam boiler may then be sold and the engine tender may devote nearly his whole time to other duties.

The low price of small motors may be referred to. They cost less in Paris than even steam engines, which are of course easily the cheapest of all small motors; and the introduction of good rotary patterns has rendered their availability for small industries still more marked.

We have concluded from the calculations above elaborated, and which are based upon results already obtained with the Popp system in Paris, easily improvable, that a great economy in the cost of power to small employers can be effected by the adoption of a scheme for the centralised production of mechanical energy and its distribution by the use of compressed air. The question now naturally arises: Is this encouragement of small employers a wise thing to aim at from the point of view of the whole community, or ought we not rather to repress and altogether annihilate them in order that all industrial work may be confined to large factories?

A complete answer to this far-reaching question will not here be attempted.

Statistics show that three-fourths of the mechanical power now used in the world has originated within the last thirty years; and it has also been computed that one hundred times more work is done by the aid of machinery at the present day than by the combined efforts of the whole human race. The work of this vast and terrible mechanical agency must of necessity ever increase and grow in amount; it cannot in the slightest degree be limited or discontinued without the instant decline and final cessation of our material civilisation.

The great technical advances recently made in electricity and in the use of compressed air evidently point to the speedy accomplishment of this desirable result. And in a very few decades we may confidently predict the removal from our manufacturing cities of all the wasteful and noxious gas-producing prime movers now used; in their stead the employment of more convenient and more economichl secondary motors supplied from mains in the streets which lead the working fluid from well conducted and favourably situated power supply stations. When the time comes, compresshd air as an energy medium will be found to be an irrepressible young giant demanding and exacting his due recognition.

RETAINING WALLS.

The Editor CANADIAN ENGINEERING NEWS:

The concluding paragraph of an article headed "Earth pressure and retaining walls" in the February 11th number of the *Engineering Record* of New York is as follows:— "The rule which makes the thickness of "base of a well bonded retaining wall one-"third to an half the height is eminently "sound and sensible, and it is no less so be-"cause theoretical considerations as well as "experience lead to it."

This is good advice.

Quebec is pre-eminently a city of retaining walls all along the north side of most of its east and west streets sloping laterally as they do towards the river St. Charles, and the scores of these walls which I have had to rebuild since I have been city engineer--now 27 years—fully bears out the rule.

Had this rule been adhered to by the engineers who were brought out here from Europe to build our new docks, and proper drainage put in from the rear to carry off the sand, percolating rain water and melted snow, we would not now be witness to the gradual giving away of the embankment wall of the Louise jetty, some 4,000 feet in length, and of the outer or eastern flank of the so-called "cross wall," built at a cost of over three millions of dollars, and to the foolish attempts now being resorted to of tieing in or anchoring them to the embankment by iron rods which at any rate to be of any use, should run the full 300 feet across the bank to the outer face of the cribwork on the opposite side, instead of relying on the resisting power of 50 to 100 feet of the sand-filled area between the walls.

And these walls required the greater ratio of base to height on account of their being almost all the year round loaded with the surcharge of mountains of coal, a circumstance which should have been well known in advance and provided for.

The bulge is now as much as 18 inches at some points and annually increasing to an alarming extent, and the otherwise beautiful sight of a perfectly straight line of heavy coping nearly a mile in extent, is thrown into a series of the most unæsthetic curves and crooks.

Nor would the Montreal revetment wall along the St. Lawrence have given away as it has done in many places after less than 50 years, and has been doing for many years past, had the wall been made of proper thickness with suitable back-filling and drainage to draw off water and thus stay the otherwise irresistible effects of frost and earth pressure.

The Quebec fortification wall all along its western side and the citadel along its northern face, both built some 80 years ago, have their earthern ramparts—some 20 feet in height or less—supported by walls which are 8 feet thick at base, 2-5 or 40% the height, and they still stand firm as ever.

The fact is, Sir, that the best and safest plan is, in every doubtful case, or where the nature of the filling may not continue to be satisfactory, to assimilate the wall to a dam wall by resisting the thrust of water, which the filling may become equal to in stress and even heavier in the case of a sand backing becoming quicksand when saturated with water, and that may happen where weepers after years become obstructed and refuse to let the water pass.

We should always assume the very worst conditions (as in old walls it may come to that) of both thrust and resistance, *i.e.*, the greatest pressure and least power of resistance, and this will be the case if we consider the filling to act like a fluid and the masonry not to exceed 150 lbs. to the cubic foot, to which it may be reduced by raking and working away of the mortar, and the cohesive power of the mortar to have been reduced by time to, say, 100 lbs. to the square foot (together 250 lbs.) when the stones may be assumed to slide, the one upon the other as if laid dry, under a force of half their own weight and adhesion; the initial force required to start them being .71 for stone on stone, but this co-efficient—when in motion —reduced to .7 of itself or to .5 since $.71 \times .7 = .497$; whence it is apparent that in such an extreme case, it would take just half a cubic foot of masonry to balance or withstand the pressure due to one foot depth of water backing from above, and so on increasing downwards in thickness in the same ratio of ½ to 1, or 5 feet thick of base to 10 feet depth of water, 10 feet base to 20 feet of water and so on of any other height, adding to the thickness if stress made greater by a surcharge.

And in case of absolutely saturated sand or quicksand, the wall would have to be built at base of thickness equal to its height if we suppose a cubic foot of saturated sand to weigh 125 lbs. or equal to the resistance of half a cubic foot of the retaining masonry and its adhesion; just as in case the filling were of iron or leaden balls or spheres and thus assimilable to so much fluid or melted lead or iron, or the backing composed of mercury which is 15²⁄₃ times the weight of water, the wall at bottom would have to be as many times in thickness half the height, as the backing were times heavier than water and this thickness again added to for surcharge of any kind.

C. BAILLARGÉ,
City Engineer,
Quebec.

TESTING HOUSE-DRAINAGE AND SANITARY MEASURES.

The subject of house-drainage and sanitary appliances is at present so prominently occupying public attention that it behoves everyone, either directly or indirectly interested in the work connected with it, to make himself thoroughly and practically acquainted with every detail of its latest phase, and to prepare himself to carry out, at the shortest notice, the most modern and the most approved of the requirements now recognised to constitute a really safe state of things, from a sanitary point of view.

In the controversy which has for some years been going on a wide difference of theory and divergence of practice have been apparent, but on one point all participators in the argument seem to agree; and, whether they be doctors, engineers, sanitary inspectors, town surveyors, amateurs, or sanitary impostors, they are all at one in the universal condemnation of the plumber. In lectures and letters it is "the careless workman" who is to blame; in reports and scientific papers it is "the ignorance or culpable neglect of the plumber" which has caused the mischief, and so on to the end of the tether.

That much should be written and more should be said on a subject which concerns the vital well-being of the whole community is not surprising, because it always is the case that whenever a question of the utmost importance has been systematically ignored for generations, and is at last recognised, a host of superficial critics and would-be teachers rise up, like the mist from the earth, and envelop the whole controversy in a fog.

Whether the temptation to condemn the modern plumber is justifiable is decidedly open to doubt probably it is the same in his trade as in that of architects, engineers, and others, that is to say, there are many very ignorant and many fully qualified; but a universal and unreasoning condemnation is certainly neither fair nor charitable.

The true point of attainment, however, for the plumber is not to prove whether or not all these strictures have been justly applied in the past, but to set his mind upon the determination that they shall never be justly applicable in the future.

The principles of sanitary science are so simple that, in putting them into practice, no plumber or workman of ordinary intelligence should find any real difficulty.

In bringing his mind to bear upon the question, the plumber may start with the settled conviction that no system of drainage has yet been introduced which does not largely create sewer-gas—generally in the forms of sulphurretted hydrogen, nitrogen, and carbonic acid. How best to keep this gas from entering the house is the problem to be solved, and one great element of insuring this is, from time to time, to apply a practical and efficient test to the existing sanitary appliances, and to determine that, whatever may be the general arrangement of the drainage, at least there should be no defective joints or leakage into the interior of the building.

The testing of sanitary work is not, perhaps, so very simple as at first flush it may be imagined, because a truly exhaustive test should include that of the eye and sensible perception, as well as the usual mechanical or chemical tests.

The usual methods of testing drains and sanitary appliances in a practical manner are as follows:—

1. The water test, which is chiefly applicable to drains and such pipes as run nearly horizontally under the basement floors.

2. The smoke test.

3. The paraffin or peppermint test, which includes keen perception in the olfactory senses.

4. A personal inspection of every detail; and this should include the operations of the senses of sight, smell, touch, taste, and hearing.

Broadly speaking, the first three tests should be applied to every part invisible, and the last to all visible parts; but, of course, as to the last, a combination is often desirable.

If called upon to test the sanitary arrangements of a house always take care to start at the beginning, and carry it through to the end in a systematic manner.

By starting at the beginning is meant either the highest level in the roof or the lowest level in the basement of the house.

Frequently the inspector enters at the ground-flour level, and is forthwith introduced to some pipe or other work at the nearest point; but this should be resisted, and he should at once proceed to the lowest point in the building and commence there. The lowest point in the basement or foundation is, as a rule, a better place to start from than the roof.

The water test is especially suitable for trying the state of all pipes in the basement and foundation, especially when they are buried in concrete, or otherwise hidden from view.

Having ascertained that certain pipes must run under the basement, proceed to find where the same join the drain, manhole, or disconnecting chamber in the area or back yard, as the case may be.

(To be continued.)

ANCHOR ICE.

The Editor CANADIAN ENGINEERING NEWS.

I notice in the first number of your paper which I feel confident will soon become an established authority for matters appertaining to the Engineering profession in Canada, an article on the "Toronto Conduit accident," the inference being that the screens were clogged, and there appears a doubt as to the real cause of the accident. Having had considerable experience with the maintenance of this class of work, in more northerly climates where yearly difficulties of this description have to be guarded against, I trust that this letter may be the means of drawing attention to the necessity of adopting precautions for preventing the recurrence of such accidents, the primary cause of which are evidently not fully understood in places which are not troubled yearly with the dangerous risks to water works from "anchor ice" or "frazil." I noticed about last Christmas time that the strong winds and low temperatures prevalent in Western Ontario would have a strong tendency to make anchor ice which is formed by the wavelets freezing and forming ice in small detached needle or crystal form ; one of the peculiarities of this ice formation being that the needles or crystals will strongly adhere to each other or to any solid body they may come in contact with, and form in a very short time, even in depths of water over 25 feet impenetrable obstructions very difficult to remove, ordinary drift ice has not this property it will only float near the surface, and I have never considered it dangerous. My theory of the accident is that anchor ice formed extensively in the lake, and was drawn into the opening or screens, hermetically sealing the inlet to the pipe, the pumps emptying the pipe, with the result that the pipe lifted. If the formation of anchor ice had been understood, and the necessary precautions taken, it is very certain to my mind that this accident would have been avoided.

Yours very obediently,
ROBERT SURTEES, M. Can. Soc. C.E.
City Engineer, Ottawa.

CANADIAN SOCIETY OF CIVIL ENGINEERS.

The annual meeting of the Canadian Society of Civil Engineers was held yesterday at the Society rooms. Mr. John Kennedy, president, was in the chair, and among others in attendance were Sir Casimir Gzowski, K.C.M.G., and Mr. T. C. Keefer, C. M. G., past presidents, and Messrs. E. P. Hannaford, P. A. Peterson, K. W. Blackwell, P. W. St. George, R. Surtees, Ottawa; Col. Gray, T. W. Jennings and Alan MacDougall. Toronto; George Mountain, T. Munro, James Shanly, W. E. Gower and J. S. Armstrong. The annual report was read and adopted. Discussion arose as to the Chicago exhibition and the placing of the Canadian society as hosts with the American society for the reception of foreign engineers. This was decided on. The Gzowski gold medal for the best mechanical paper read before the society during the year was not awarded, owing to the death of Mr. Gisborne, one of the committee. The incoming council will, however, act in the matter.

After the election of officers Mr. Kennedy read his annual address.

PRESIDENTS ADDRESS.

Our by-laws happily contain no clause compelling the President to make what is known as a presidential address, in which the state and advance of the whole field of engineering knowledge are reviewed. Such an address is becoming well nigh impossible, because to be really complete it must reach over so wide a range of engineering as to require more time and research in the preparation than can be afforded by any busy engineer, much more time in the delivery than can be afforded at an ordinary engineers convention.

I am therefore sure that I shall have your approval when you hear that instead of attempting any such address I desire to merely say a few words upon matters which intimately concern ourselves as Canadian Engineers and members of our one national society of Engineers.

Our society was, as you know, founded only five years ago. Its formation was received with so much favour that it started almost full-grown. The majority of Canadian engineers joined almost as soon as they became aware of its existence and constitution. Others approved and joined shortly afterward, until now we have a gross membership of 647. The aggregate of the full and associate membership has reached 404 and this number must include almost all experienced engineers in active practice in Canada.

How then are we benefitted by membership in the society. Firstly, and obviously, I think, through the papers which are read and discussed. These are largely records of successes, or of failures, in dealing with the problems of Canadian engineering, and as such are of peculiar value to us. A description of the foundations of the most successful bridge on the Ganges is of less real importance to us here in Canada than is an account of the overthrow of a trestle bridge on Rice Lake or the springing of piers on the Ottawa by the movement of ice. A discussion upon the Deltas of the Nile, or the Mississippi, is not nearly as useful to us as one upon the anchor ice of the St. Lawrence.

There are, therefore, benefits to be derived from the papers of our own Society which can be had from those of no other Society.

But there are sometimes greater and oftener overlooked, advantages in the presentation of papers, than in the receiving of them. In a recent Circular of the American Society of Civil Engineers, it is stated in effect that the presentation of a paper of any merit is followed by a rise in the standing of the author, and often by more substantial professional advantages. There are many engineers who have become known to us only by means of their papers, or their contributions to discussions, and whom we would recommend for engagements or consultations, solely because of the ability and activity of thought which they have shown by such means. Papers and discussions contributed to our Society are, therefore, ready means by which we may not only add to the knowledge of our brother engineers, but by which we may very properly benefit ourselves.

So much for the past and present ; and now a word as to the future of the Society. If what I have said be correct, it obviously follows that we shall make better engineers of ourselves and of our brethren by each making the best contributions to the common stock of professional knowledge which our abilities and opportunities enable us to do. And generally too, we shall best accomplish this by contributing through our own society than through foreign or other societies to which any of our members may belong.

From this brief review of the history of the Society and outlook upon its future, I think we are warranted in saying that It has already justified its existence, and that it may be made the means of conferring still greater benefits in future, not only to its members, but to vast interests, whose success is dependant upon engineering skill.

At the conclusion Mr. Hannaford was installed as president for the coming year, and returned thanks for the honor done him, assuring the society that it would always command his services.

A nominating committee was appointed.

Mr. Alan Macdougall moved, seconded by Mr. Dodwell, that a committee be appointed to consider the question of forming the society into a close corporation, which, after discussion, was adopted and the committee nominated.

Mr. Macdougall's speech will be found elsewhere.

On Mr. Sproule's motion a committee was appointed to consider the rules on professional ethics.

The following are the officers elected: President, E. P. Hannaford, Montreal ; vice-presidents, Thomas Munro, Coteau Landing ; P. A. Peterson, Montreal ; W. J. Jennings, Toronto : treasurer, Herbert Wallis, Montreal ; secretary, C. H. McLeod, Montreal ; librarian, Wm. McNab, Montreal. Members of council—H. T. Bovey, Montreal ; St. George Boswell, Quebec ; H. D. Lumsden, Toronto ; P. W. St. George, Montreal ; J. D. Barnett, Stratford; Alan MacDougall, Toronto ; G. C. Cunningham, Montreal ; G. A. Mountain, Ottawa ; C. K. Domville, Hamilton ; C. H. Keefer, Toronto ; H. S. Poole, Stellarton ; Thomas Ridout, Ottawa ; F. R. F. Brown, Moncton; M. Mohun, Victoria, B.C.; F. R. Redpath, Montreal.

THE EVENING SESSION.

Mr. E. P. Hannaford, the newly elected president, occupied the chair at the evening meeting, which was graced by the presence of the Governor-General.

Prof. J. T. Nicholson contributed an extremely able paper on "Transmission and Distribution of Power by Compreesed Air."

A vote of thanks was accorded Professor Nicholson. The President spoke of the honor which had been conferred upon the society by the presence of the Governor-General, referred to the popularity which His Excellency had attained in the Dominion, and said that wherever he went his career would be watched with interest by Canadians.

His Excellency spoke of the excellence of Prof. Nicholson's paper, which contained much useful matter that could be grasped by the non-professional mind, and thanked the society for the kindness which it had always accorded him since the day it did him the exceptional honor of enrolling him as an hon. member. The certificate he then received now hung in what he called his workshop ; but when he got home it would hang up in a real workshop, for as an amateur he had always taken an interest in engineering. He trusted that the society would long go on gaiding strength, and being a blessing and utility to all concerned.

CANADIAN SOCIETY OF CIVIL ENGINEERS.

A PLEA FOR CLOSE CORPORATION BY MR. ALLAN MACDOUGALL OF TORONTO.

Mr. Macdougall said, in presenting the petition of members resident in Toronto and the North West, these documents were the natural outcome of the paper which he had the honour of presenting to the Society last spring, and which was printed in the Transactions, Vol. 6, Part 1 ; he was aware that he took a very important step in the history of our Society, and also in the history of the profession. The question was one which at that time was surrounded by many difficulties, but since then he had noticed with great pleasure that others had been engaged in the same subject as himself, and a great many of the difficulties with which this action was hedged in had been removed. He might state that the correspondence which he had received since his paper was published, contained the greatest assurances from all over the Dominion, as these papers which he had presented to the chairman show. The action of the engineering papers in publishing editorial articles on "Professional Ethics," show how men have been thinking; all over the Continent men are studying this important question. it is apparent to all, that our profession is in a most unsatisfactory condition and how to remedy this, how to place ourselves in an established position, is a question which we all ought to consider as scientific men. Mr. Macdougall said he would not take up their time by any address because it is a subject that appeals to every one present, and in fact to every Engineer. The views stated in his paper and also those of the leading Engineering papers in the States have been placed before the public. More particularly, since Mr. Whinery had read his paper before the Cincinnatti Society of Civil Engineers, the American Society of Civil Engineers and some of the most important and prominent Societies, both in the East and Western States have taken up this question very warmly. He was surprised to find what an unanimity of opinion there was on this point, and also how anxious they all seemed to be to have some recognition of our professional status, of having the profession placed on a footing, that there should be some disciplining power, some licensing of members the same as in the older professions of law and medicine. In some societies, such as the Dominion Land Surveyors and our several Provincial Land Surveyors' Associations, they are enabled by Act of Parliament to discipline their members; in the Province of Ontario and in the North West Territory they have the power of prohibiting unlicensed surveyors from practising, and they are also enabled now, to control their examinations ; to appoint the examining body and are able to do everything and have all the powers of a corporate body. The Architects in this province and in Ontario have also some small powers, and in the Province of British Columbia they have got so far that they have the power of deciding who shall be practising Architects. There is no doubt whatever that the result of this legislation has been of the very greatest benefit to this profession in these Provinces.

All of us who are in practice know how many things there are which ought not to be submitted to. In municipal work, for instance, where one man is called upon to bid against another, the work comes to the lowest, whereby it is not so much a question of reputation as it is a question of how many friends one may have. The position is extremely unsatisfactory, and he thought if we could get some announcement made now it would be a step in the right direction ; but he hoped the time was not far distant when we should be a Close Corporation, with the Canadian Society of Civil Engineers the controlling power, with the right of disciplining our members. More than the foundation of this has been already laid in our society, it has now been in existence for over five years, and it has had a beneficial effect upon Engineers all over the Dominion. We all feel that we are members of a large corporation, and that there is a strong *esprit de corps* being developed among us. We are in a very fortunate position in this country, in so far as we are the only Society of Civil Engineers in the Dominion, and he hoped we would be able to keep that Society the one great leading Society all over the Dominion. The American Society of Civil Engineers had been divided into a number of societies, several of which appeared to be so strong that they seem disposed to push the older or the parent society aside and ignore it altogether. In the United States, where each State has the power of making its own laws, independently of the Federal power, it might be difficult to have one ruling society, but he hoped it would come to pass that there would be one national society in the United States, with the other societies submitting to it in everything.

OPENING OF THE ENGINEERING AND PHYSICS BUILDING AT McGILL COLLEGE.

ONE OF THE MOST MAGNIFICENT TECHNICAL EDUCATIONAL PLANTS ON THE CONTINENT.

One of tne mos, striking examples of the good which wealth judiciously and generously spent can accomplish is afforded by the magnificently appointed Engineering building, the gift to McGill University of its munificent patron, Mr. W. C. McDonald, which was formally opened yesterday by His Excellency Lord Stanley. It is not only an imperishable monument to his memory, but a factor in the technical education of generations to come whose importance cannot be overestimated, since within its walls the student engineer receive not only a theoretical, but a practical education in the use of the machinery, which will be under his control when he is once embarked in his profession.

The machine shops are bright, well lighted and cheerful. The building is fitted with an elevator, lit with electricity, and heated with exhaust steam from the engine. Steam is furnished from five Babcock & Wilcox boilers, each of 60 h. p., and for the instruction of marine engineers there is a marine engine of 175 h. p. similar to those used on board torpedo boats enclosed in an airtight chamber like the engine rooms on that class of craft.

In the thermo-dynamic rooms the central object is a large triple expansion engine, while round the room are placed engines and steam pumps of every variety, and gauges, governors, injectors, etc., of every class. All the machinery is belted to pulleys on the shafting and can be put in operation at a moment's notice. In the electrical room stand dynamos and motors of every pattern, all ready for instant use; while on the walls are a variety of switchboards, cut-offs, etc., to instruct the student engineer.

The hydraulic room is one of the most interesting in the whole building A monster hydraulic tank, thirty feet high, is the prominent feature; while opposite it are the apparatus for testing the weight and force of water. Next to this is the testing room, where the feature is a 100 ton Buckton hydraulic testing machine for ascertaining the breaking point of any material. There is also a 75 ton Emery testing machine worked by an hydraulic pump.

The fitting and machinists shops are filled with the newest machinery for iron and steel working, and some excellent specimens of the skill of the students in lathe and vice work were shown. The blacksmith's shop, with its forges and anvils, and the foundry, with its row of furnaces and numberless sand moulds, are also interesting from the completeness and perfection of their details.

Upstairs are the carpenters' and patternmakers' shops, with their rows of bright steel lathes and the moulding, tenoning, matching and planing machines, and then there is the mechanical laboratory with its triumphs of mechanical science.

Above again are the class rooms, the lavatories, professors' rooms and laboratories, each and all fitted with every appliance that modern science can suggest or money can buy. The whole forms one of the most magnificent technical schools on this continent.

THE OPENING CEREMONY.

The opening ceremony was fixed fon ten o'clock, and sharp on time the private sleigh of Sir Donald Smith, in which were seated the Governor-General, Lord Kilcoursie, A. D.C., and Sir Donald drew up to the door, the Hon. W. Walsh, A.D.C., following in another sleigh. The Dean and faculty, attired in their robes, received the distinguished visitors. The party retired to Prof. Bovey's room, where the Governor-General and Sir Donald, who is chancellor to the University, put on their robes, Lord Stanley wearing the scarlet robes of an LL.D. They then proceeded to the library, where several introductions took place, after which a start was made for the lecture hall up stairs, the students, who had enlivened the interim by singing college songs, starting up "God Save the Queen" as His Excellency, accompanied by the Chancellor, the Dean of the faculty and the corporation of the University, entered. Among those either in the procession or seated in different parts of the hall, in addition to the Governor-General and Sir Donald Smith, were Chief Justice Lacoste, Sir Casimir Gzowski, Hon. G. Ouimet, Mr. Justice Davidson, Mr. Justice Wurtele, Rev. Prof. Clark Murray, Mayor Desjardins, W. C. McDonald, Prof. Alex. Johnson, Prof. Bovey, Rev. Dr. Barclay, Rev. Principal Adams, Rev. Principal MacVicar, Dr. Raymond, James A. Cantlie, E. P. Hannaford, John Kennedy, Principal Grant, S. Finley, Prof. C. H. McLeod, E. B. Greenshields, Dr. D. McEachran, Rev. Prof. Shaw, R. Sturtees, Rev. Dr. Douglas, E. Perreault, W. E. Gower, Prof. Darey, C. J. Fleet, Prof. Carus Wilson, Herbert Wallis, Principal Archambault, C. E. Dodwell Poole, (Sellarton, N.S.,) Prof. Chandler, R. B. Angus, Prof. J. T. Nicholson, George Hague, John Birkinbine, ex-president of the American Institute of Mining Engineers; Andrew T. Taylor, James Ferrier, Prof. Harrington, P. A. Peterson, R. W. Heneker, chancellor of the University of Bishop's College; Prof. A. R. C. Selwyn, Richard White, T. C. Keefer and Joel C. Baker.

ADDRESS TO HIS EXCELLENCY.

The proceedings having been opened with prayer by the Rev. Professor J. Clark Murray, Sir Donald Smith rose, amid much applause, and read an address to Lord Stanley.

Mr. W. C. McDonald, the donor of the two magnificent buildings, then presented to His Excellency the keys of the Engineering and Physics buildings, in a box made of teak from the Beaver, the first steamship to round Cape Horn; the key of the Engineering building being made from the first metal tested in the laboratories,

In replying to the address, Lord Stanley thanked them for the cordial manner in which he had been received as the representative of his Sovereign in what he might call his native University of McGill (applause), and assured them that these tokens of loyalty and personal devotion to the Sovereign would be presented by him in due course to Her Majesty, who was at all times concerned in the welfare of her subjects, and especially those in the Dominion of Canada. He was very much pleased and gratified at being permitted to be present to do honor to Mr. McDonald (cheers), who by his munificence had erected two such magnificent buildings, and so well and completely equipped, for the faculty of applied science. He then referred to the dean of the faculty, Prof. Bovey, who had enabled him to look at some of the equipment of the building. What he had seen had simply astonished him. He had had the good fortune to see many of the appliances, and he must say that he had never seen anything equal to it. He referred to the apparatus he had inspected, and remarked that the object of the civil engineer was rather to promote and save life than to waste and destroy it, as was done unfortunately in older lands. He had no doubt that as a result of all the appliances with which the students were supplied in these workshops, new discoveries, fully worthy of the highest Canadian science, would be made, and announced that he was glad to welcome so many distinguished visitors from the other side of the border. We were always glad to welcome men of science, or any person, in fact, from across the border, to show them that we in Canada were in a thriving and healthy condition, and he trusted that before the day was over they would own that even the Massachusetts Institute of Technology could not surpass some of the work which they would see within those walls. This was, indeed, high praise, for nowhere, except in the United States, had more benefactions been made or put to better use.

ADDRESS FROM THE STUDENTS.

Mr. J. A. MacPhail, Mr. J. H. Featherstone and Mr. Gill then came to the front, Mr. MacPhail reading an address on behalf of the undergraduates.

Premier Fielding, of Nova Scotia, heartily joined in the congratulations to McGill in this, the new evidence of prosperity and success, and wished it even greater prosperity in the future than in the past.

Chief Justice Lacoste said that the gratitude not only of McGill was due to Mr. McDonald for the fine building, but the gratitude of all Canadians was due him.

Major Desjardins expressed the gratitude of the city at the presence of Lord Stanley, and said that the city was proud of McGill, as not only a Montreal, but a Canadian institute. It was not only a benefit to the citizens, but to the world.

Addresses were also delivered by Dr. Howe, president of the American Institute of Mining Engineers; Mr. Birkinbine, ex-president of the same association; Mr. C. McDonald, vice-president of the American Society of Civil Engineers; Dr. Raymond, ex-president of the American Institute of Mining Engineers; Mr. E. P. Hannaford, Sir Casimir Gzowski, Mr. T. C. Keefer and Prof. Bovey.

The Governor-General then formally declared the building open, and the proceedings terminated.

To find out the extent of a crack in metal, rub the cracked metal surface with petroleum, then wipe it, and then immediately rub on chalk. The oil that has penetrated into the crack exudes, and indicates just where the crack stops.

STATIONARY ENGINEERS.

A LARGE AND REPRESENTATIVE GATHERING AT THE CITY HOTEL.

One of the most representative gatherings that has ever sat around a festive board in this city met at the City Hotel on Saturday evening, when the members of the Canadian Association of Stationary Engineers and their guests, to the number of eighty, sat down to the third annual dinner of the Association. Most of the speeches were of a technical character, but one or two are of importance to the public, especially that of the representative of the Brotherhood of Locomotive Engineers, who put a quietus on the stories that have been put in circulation, to the effect that the engineers were preparing for a grand strike during the World's fair.

It was after 9 o'clock when the president, Mr. Joseph Robertson, called on the diners to be seated, and as befitting men who daily have thousands of lives in their care, before commencing the repast he asked Brother James Elliott to ask a blessing. The menu was a tasty yet a unique one. You could start with "lubricated" oysters, and go through "indicator" soup, "eccentric" entrees, "high pressure" ham, or anything else one liked in this style. After "Our Queen and Country" had been loyally toasted, letters of regret were read from Major W. H. Laurie, Captain James Wright, A. E. Edkins, president of the Executive Board; A. M. Wickins, A. J. Darling and Robert Mitchell. The toast of "Electric Engineering" was first responded to by Mr. C. C. Robertson, who gave a resume of the progress it was making, creating some amusement at the same time by his descriptions. He also alluded to the forthcoming opening of the new buildings at McGill College, which were being stored with latest appliances in electrical engineering. "Steam Engineering" was talked about by Messrs, Couper and John Smillie. Mr. Couper in his remarks, referred to the advancement the profession was making, alluding incidentally to the recent case of the break of the shaft on the Umbria which could not have been repaired while at sea some ten or five years ago. He said that the greatest credit was due to Engineer Tomlinson and his assistsnts for the able manner in which they had accomplished their task. Mr. Smillie gave a description of the engines of the days when he was a boy, and the strides engine building has been constantly taking, he believed it was in its infancy. He said:

I do not know what to say in response to such an important toast as that of "Steam Engineering." Mr. Couper has told us that 200 lbs. pressure on the square inch is being carried by some of the ocean marine boilers, and mentions some other points of progress made in Steam Engineering that ten years ago could not be accomplished, I agree with all he has said and believe that we are no more at the limits of Steam Engineering possibilities that they are with Electrical Engineering. To mention some of the changes that have taken place since I was a boy, I was at a coal mine with my father, he had three different types of Engines at this mine, the one for winding the coal from the mine was what was called a Table Head Engine, the second used for pumping was a common Beam Engine, but the third is the one I have special reference to, a common Atmospheric Engine of the old type with boiler in keeping. Mr. Couper drew your attention to the fact that 200 lbs. pressure was the point reached today, but the boiler of this engine carried a pressure of 5 lbs. on the square inch, and it became a serious matter should it by any means reach 10 lbs., many of you are not familiar with this type of Engine, this engine had no rotary motion, the Pump Rods were attached to the end of the Beam, and Piston Rod at the other, there were what was called Spring Beams at each end of engine beam, and hornes fastened to the engine beam to prevent the piston from rising or falling out of its working space, and the Cylinder Head was open, and my duty was to go along the road and gather manure to keep the packing rings tight so that it would not draw air and spoil the vacuum, and I can assure you, Gentlemen, that this same old engine did good work, but this will serve in some measure to show the advance that has been made from the type of engine and boiler I have just mentioned and the point of progress stated by the previous speaker, is an indication of what has been accomplished in Steam Engineering, and I believe that this Association which has been formed for your mutual advancement will in no small measure help forward this work, but I have in my possession a copy of By-laws of a Stationary Engineers Association that was formed in 1857, so that you see that the Engineers of old were men who foresaw just as you have done the need for such an Organization as you have here to-night

I trust that your Society may go forward in the good work so well begun until it reaches that point of perfection which I know to be the aim and ambition of all of you.

The speakers to the toast of "Our Manufacturing Interests," were Messrs. Hugh Vallance and Samuel Fisher.

"The Faculty of Applied Science" was the next toast on the programme. Mr. W. E. Gower, of the *Canadian Engineering News*, responded, and gave a lucid description of the strides going on in McGill, especially regarding applied science.

The reply to the next toast that, of the "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, 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 a second boiler and the engineer asked me place the safety valve 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 right 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 40 lbs. 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 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 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.

THE WORK OF INSPECTION.

"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 illustrstions, 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 full of scale that it touched the tubes from end to end, and have had to weld a wide chisel into a once inch pipe to get it out of the hand hole. I have found 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 stays 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.

THE GOOD ENGINEER.

"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 in 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 its ashes only. Go into his engine room and you do not need creepers on to keep you from slipping on the dirty, oiley 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 LOCOMOTIEE ENGINEERS.

The next toast was that of the "Brotherhood of Locomotive Engineers," which was coupled with the names of Messrs. Thomas Clark, Samuel Bricklay and Laberge. Mr. Clark referred to the previous speaker whose remarks he thoroughly endorsed. He thought it was against the interest of any employer to employ as an engineer any one who had not an association certificate.

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 ever had, and that employers were beginning to find out that it was in their interests to employ only association men, who had to be experts to be members. The question of wages never came up at their meetings. They were held for the purpose of mutual improvement.

Mr. Geo. Hunt gave his experience in the meeting in New York for the purpose of arriving at the best class of engine for electric lighting. He did not favor the triple expansion engines, and will give in our next number in detail his views on this subject.

THE INTERNATIONAL CONVENTION OF MINING ENGINEERS.

The American Institute of Mining Engineers,
The Province of Quebec Mining Association,
The Province of Nova Scotia Mining Association,
The Province of Ontario Mining Association,

All met in Montreal on the 22nd Feb., and held their annual meetings in the various Lecture Rooms of the Physics Buildings, McGill College, when the officers of the different associations were elected, after which various papers were read and discussed on this date and the following days of the convention. Among the most important in the American section were:—

- TITANEFEROUS ORES IN THE BLAST EURKACE, by Mr. Augusto J. Rossi of New York.
- THE MANUFACTURE OF METALLIC MANGANESE, by Mr. F. L. Garrison of Philadelphia.
- UNFREEZABLE DYNAMITE, by Mr. E. E. Russell Notman of New York.

The following officers were elected for the American Institute of Mining Engineers: President, Henry M. Howe, Boston; vice-presidents, A. J. Bowie, jrr., San Francisco; Robert G. Leckie, Londonderry, N.S.; E.G. Spilsbury, New York; managers, H. H. Campbell, Stretton, Pa.; W. S. Sheafer and A. M. Shook, Tracy City, Penn.; treasurer, Theodore D. Rand, Philadelphia, Pa., secretary, Rossiter W. Raymond, New York.

In the Canadian sections the most important papers read and discussed were:

- ELECRICAL COAL CTTTING, by Mr. James T. Burchall, Sydney, N.S.
- NOTES ON THE ORES AND PLANT OF THE PICTON CHARCOAL IRON CO., AT BRIDGEVILLE, N. S., by Mr. E. Sjostedt, Bridgeville.
- THE MANUFACTURE OF CHARCOAL IRON FROM BOG AND LAKE ORES OF THE THREE RIVERS DISTRICT, QUE., by Mr. P. H. Griffin, M.E.. Buffalo.
- THE ELECTROLYTE EXTRACTION OF METALS FROM THEIR ORES, by Mr. W. T. Gibbs, F.C.S., Buckingham.

On Friday, the 24th, most of the members attended the opening ceremonies of McGill College, and the Conversazione in the evening.

On Saturday, the 25th, the whole of the members of the Convention visited, by special train, the Radnor Forges of the Canada Iron Furnace Co., Limited, and spent a thoroughly enjoyable day. In the evening an "At Home" was given by Sir Donald and Lady Smith.

Some of the papers mentioned above we hope to place before our readers in our following issues.

Mr. B. T. A. Bell, the Secretary of the Quebec Mining Association, with his usual ability and hard work, did a great deal towards making the Convention a success.

The following officers were elected for the Quebec Mining Association:—

Hon. George Irvine was re-elected President.

For vice-presidents the following gentlemen were chosen without division:—Capt. R. C. Adams, Messrs. John Blue, Jas. King, M.L.A., and R. D. Hopper.

Mr. B. T. A. Bell and Mr. A. W. Stevenson were elected as secretary and treasurer respectively by a unanimous vote. The council elected for 1892-93 is as follows:— Messrs. the Hon. Judge Dugas, W. H. Irwin, L. A. Klein, F. B. Buck, J. Burley-Smith, George E. Drummond, S. P. Franchot, J. J. Penhale, and Col. G. Lucke.

NEW PUBLICATIONS.

THEORY OF STRUCTURES AND STRENGTH OF MATERIALS. By Henry T. Bovey, M. Inst. C. E., M. Inst. M. E., Professor of Civil Engineering and applied mechanics,. Montreal. New York, John Wiley & Sons; and Wm. Drysdale & Co., Montreal, 8 vo, cloth; pp. 817; over 500 illustrations and diagrams. $7.50.

The dedication of the book is a nice example of Mr. Bovey's aptitude for recognizing the fitness of things—"Dedicated to William C. McDonald, whose benefactions to McGill University have done so much to advance the cause of Scientific Education." The names of the Dean of Faculty and its benefactor must always be coupled together.

A new text book of applied mechanics, especially that portion which treats of the design of structures, is necessarily a repetition for the most part of principles and processes already elucidated more or less clearly in several different ways. The literature on the mechanics of the design of structures is voluminous beyond that on almost any other class of engineering design, and any claim to consideration, therefore, which a new treatise has beyond others on the same subject rests largely upon the greater clearness and conciseness with which well-known principles are treated. Considering how well the field is covered in these respects by the many existing textbooks on structural design, and the very few really valuable additions to the general theory from year to year, there can hardly be said to be any very great void for textbooks of statics; yet a very large proportion of the books coming before us each year are of this character. The book whose title is given above is the latest of these, and is in general much more worthy of consideration than the majority of them.

The author's reputation is a guarantee of clearness and conciseness in the treatment of the matter which must naturally be drawn from the work of others; and in addition there is a considerable amount of new matter—new, at least, in so far as its inclusion in a textbook is concerned. The most important features of this new matter are the articles on "Surface Loading," condensed from a paper read before the Physical Society, by Professor Carus-Wilson; on "Flexure of Columns," from a paper read before the Can. Soc. C. E., by Mr. Findlay; on the "Efficiency of Riveted Joints," from a paper by Professor Nicholson, published in the "Engineer," in 1888, and the author's discussion of "Maximum Shearing Forces and Binding Moments," "Flexure of Long Columns," and "Theorem of Three Moments."

The work is divided into three chapters. Chapter I. treats of framed structures, beginning with the simplest frame of three members, and taken up in the order of complexity the various common types of bridge and roof trusses. Chapter II. is devoted to the general discussion of shearing forces and bending moments. Chapter III. defines and discusses the general principles of stress, elasticity, work, energy, momentum, inertia, impact, etc., etc. Chapter IV. discusses stresses and strains and their relation and application in designing retaining and reservoir walls and in earth foundations. Chapters V., VI., and VII., VIII., IX., and X., treat of friction, transverse strength of beams, pillars, torsion, and cylindrical and spherical boilers, respectively. The last three chapters take up at considerable length the common types of truss bridges, suspension bridges aud arched ribs. A most valuable feature of the book is the large number (varying from 22 to 164) of typical and well selected "examples" (problems?) given at the end of each chapter. The total number of these "examples" is 804. The paper and typography is good, and the illustrations, consisting entirely of diagrams, are clear and fairly well printed. Altogether, our impressions of the work are most favorable.

Every student of Applied Mechanics owes to Mr. Bovey a debt of gratitude for the extreme simplicity of his deduction of a general proof of the Theorem of three moments. The chapter on pillars also contains original work on the Flexure of Long Columns. The subject of Bridges receives the attention its importance deserves, and the pages devoted to it give a peculiar value to the Book which will be at once apparent.

The reputation of Mr. Bovey is enhanced and the prestige of the University increased by the appearance of this admirable volume.

The Canada Iron Furnace Co. have sent us a very artistic and well arranged pamphlet of 75 pages, a souvenir to commemorate the visit of the members of the International Mining Convention of 1893 to Radnor Forges.

A great deal of information relates to the foundation of the smelting works some 200 years ago in the neighbourhood and makes it very interesting reading to the general public whilst the analysis of various ores and iron and the descriptions of the plant and machinery makes it valuable to those interested in iron manufactures.

POWER OF PUMPS.

No pump, however well made, can draw water over 30 feet perpendicularly below its bucket or working part, and it is found in practice that from 18 feet to 25 feet is as much as is safe to allow for suction pipe. Where the level of the water is over 25 feet below the surface, the working part of the pump must be fixed within that distance. In some cases it is difficult to fix the working power of a pump over the well. For shallow wells this is not of so great a consequence, though care should be used to avoid any choking in the bends of the suction-pipe, and allowance must be made for extra friction in the horizontal pipe.

NEW PUMPING ENGINES FOR BROOKLYN.

Commissioner John P. Adams, of the Department of City Works of Brooklyn, N.Y., has entered into contract with H. R. Worthington for three pumping engines of the daily capacity of 10,000,000 gallons each, together with boilers, etc., for the Ridgewood station, the price being $199,800. Also for two engines of similar capacity for the Milburn station at $84,350. The contract for them was awarded to Mr. T. Davidson. There is another contract with Davidson for an engine at the Underhill avenue station. The price for this is $22,750, making a total of $306,900.

They are doing things differently in Cincinati just now. A scarcity of water supply does not bother them in that city, however, as they have the Ohio river to draw from, but the authorities of Cincinnati decided to adopt a general meter system, and that the matter of purchasing a new pumping engine was indefinitely postponed, the adoption of the meter system making the new engine unnecessary. The wisdom and intelligence of the East is beginning to have its effect in the West.

ANOTHER METHOD OF MAKING CHEAP GAS.

A Chicago inventor, a Mr. De La Marre, is the patentee of a new method of making gas for illuminating or heating purposes, by decomposing water, H_2O, and running the resultant gas through two solutions, one of bichromate of potash and one of oxalic acid. In this way he claims to manufacture a gas superior to ordinary coal gas for light or heat, and at the same time extracts all gases injurious to the human system, so that the gas supplied will be as harmless to breathe as ordinary air. In addition to this the cost of a plant to make the gas would not exceed $400 for one having a capacity of 25,000 to 30,000 cubic feet per day, while a plant large enough to supply the whole city of Chicago could be built for $100,000. If his invention is not absorbed by the Gas Trust and either shelved or utilized in adding still more value to the gas certificates, Mr. La Marre may make a fortune in making and supplying his new "safety" gas, or in making and selling individual plants for private consumers or for small towns. When gas can be made for 36 cents per 1,000 cubic feet. as it is claimed can be done under this process, and that with a plant costing but a nominal sum, every town and village in America and Canada may luxuriate in gas. Now let the electric inventors come forward with better and cheaper electricity!

The air compressor used in the mechanical process of painting the Exhibition buildings at Chicago is a rotary one, which when driven by an electric motor, compresses air from 15lb. to 18 lb. to the square inch. The air is then mixed with calcimine, and both are impelled through a hose upon the surface being painted or calcimined from the nozzle in the hands of two men on the scaffolding.

USEFUL INFORMATION.

METALS have five degrees of lustre—splendent, shining, glistening, glimmering and dull.

A FIREPROOF COVERING FOR ROOFS consists of a mixture of lime, salt and wood ashes. A little lampblack should be added for colouring.

AN "INCH OF RAIN" means 1 gallon of water spread over a surface of nearly 2 square feet, or a fall of about 100 tons upon 1 acre.

VARNISH FOR PATTERNS.—A varnish which it is claimed, dries as soon as put on, gives the pattern a smooth surface, thus ensuring an easy slip out of the mould; and which prevents the pattern from warping, shrinking, or swelling, as it is quite impervious to moisture, is prepared in the following manner:—30 lbs. of shellac, 10 lbs. Manila copal, and 10 lbs. of Zanzibar copal are placed in a vessel, which is heated externally by steam, and stirred during four to six hours, after which 150 parts of the finest potato spirit are added, and the whole heated during four hours to 87° C. This liquid is dyed by the addition of orange colour, and can then be used for painting the patterns. When used for painting and glazing machinery it consists of 35 lbs. of shellac, 5 lbs of Manila copal, 10 lbs. of Zanzibar copal, and 150 lbs. of spirit.

PAINT FOR IRON.—The *Neusste Erfindungen* describes an anti-corrosion paint for iron. It states that if 10 per cent. of burnt magnesia, or even baryta or strontia, is mixed cold with ordinary linseed-oil paint, and then enough mineral oil to envelop the alkaline earth, the free acid of the paint will be neutralized, while the iron will be protected by the permanent alkaline action of the paint. Iron to be buried in damp earth may be painted with a mixture of 100 parts of resin (colophony), 25 parts of guttapercha, and 50 parts of paraffin, to which 20 parts of magnesia and some mineral oil have been added.

RUST REMOVERS.—1. Cover the metal with sweet oil well rubbed in, and allow to stand for 48 hours; smear with oil applied freely with a feather or piece of cotton-wool, after rubbing the steel; then rub with unslacked lime reduced to as fine a powder as possible. 2. Immerse the article to be cleaned for a few minutes until all the dirt and rust is taken off in a strong solution of potassium cyanide, say, about ½oz. in a wineglassfull of water; take it out and clean it with a toothbrush with some paste composed of potassium cyanide, Castile soap, whiting, and water, mixed into a paste of about the consistency of thick cream.

BLASTING.—In small blasts 1 lb. of powder will loosen 4½ tons; in large blasts, 1 lb. of powder will loosen about 2¾ tons. 50 lbs. or 60 lbs. of powder, enclosed in a resisting bag, hung or propped up against a gate or barrier, will demolish any ordinary construction. One man can bore, with a bit of 1 inch in diameter, from 50 inches to 100 inches per per day of ten hours in granite, or 300 inches to 400 inches per day in limestone.

HINTS ON THE CARE OF TOOLS.

The following hints on the best means of keeping tools in good condition may prove useful to many of our readers :—

WOODEN PARTS.—The wooden parts of tools, such as the stocks of planes and handles of chisels, are often French polished, but this adds nothing to their durability. A better plan is to let them soak in linseed oil for a week, and rub them with a cloth for a few minutes every day for a week or two. This produces a beautiful surface, and at the same time exerts a solidifying and preservative action on the wood.

IRON PARTS.—*Rust Preventives.*—The following recipes are recommended for preventing rust on iron and steel surfaces :—1. Caoutchouc oil is efficient in preventing rust. It only requires to be spread with a piece of flannel in a very thin layer over the metallic surface, and allowed to dry up. Such a coating will afford security against all atmospheric influences, and will not show any cracks under the microscope after a year's standing. To remove it, the article has simply to be treated with caoutchouc oil again, and washed after 12 to 24 hours. 2. A solution of indiarubber in benzine has been found a simple means of keeping steel, iron, and lead from oxidizing. It can be easily applied with a brush, and is as easily rubbed off. It should be made about the consistency of cream. 3. All steel articles can be perfectly preserved from rust by putting a lump of freshly-burnt lime in the drawer or case in which they are kept. If the things are to be moved (as a gun in a case, for instance), put the lime in a muslin bag. This is especially valuable for specimens of iron when fractured, for in a moderately dry place the lime will not want any renewing for many years, as it is capable of absorbing a large quantity of moisture. Articles in use should be placed in a box nearly filled with thoroughly pulverised slaked lime. Before using them, rub well with a woollen cloth.

TABLE OF THE QUANTITY OF WATER RAISED PER HOUR BY SINGLE BARREL-PUMP, WITH 9-INCH STROKE.

Inches	20 Strokes per Minute	25 Strokes per Minute	30 Strokes per Minute
	Gallons	Gallons	Gallons
2 ..	124	155	185
2½ ..	192	240	283
3 ..	277	346	415
3½ ..	376	470	564
4 ..	491	614	737

RELATIVE WEIGHTS OF METALS.

The weight of bar iron being	1·
Cast iron	= ·95
Steel	= 1·02
Copper	= 1·16
Brass	= 1·09
Lead	= 1·48

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