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The Canadian Engineer

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GREAT BRITAIN'S MIGHTY WARSHIPS

SOMETHING ABOUT THEIR ENGINEERING FEATURES

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Owing to the political situation in Canada at the present time, the navy of Great Britain is now very much before the public, and from recent actions, it might be intimated that the time is not far distant when the navy of Great Britain will be the navy of Greater Britain and become an imperial affair.

The columns of a technical newspaper are not a proper place to discuss the question from a political or patriotic viewpoint, but there are so many phases and aspects of the British navy and so little, apparently, known in Canada regarding its workings that it is but reasonable to assume that certain mechanical features will prove interesting reading to the patrons of *The Canadian Engineer.*

The fighting ship of today is a distinctly modern creation, and holds nothing in common with its predecessor excepting the ability to float. It is designed for one specific purpose, fighting only, and toward the accomplishment of that purpose the entire design is directed, but the following factors must receive due consideration:—

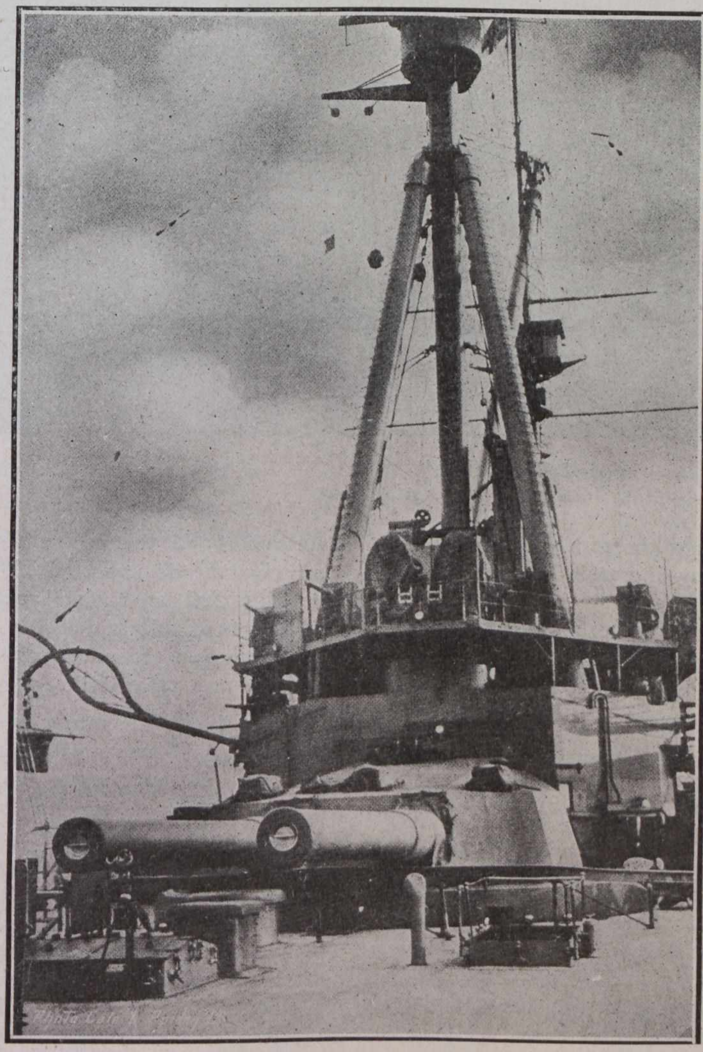
(1) The ship must carry sufficiently heavy armament to give a degree of striking power equal to anything that is likely to be met with in opposition during a time of action.

(2) The ship must have armor of sufficient strength and disposed about the vital spots in such a manner as to withstand sustained gun fire.

(3) The ship must have speed enough to enable it to manoeuvre against any hostile ship of its own type on terms of equality, if not superiority.

(4) The ship must be given sufficiently large storage of fuel—technically known as coal endurance—to enable it to keep the sea for lengthy periods and make long passages without the need of replenishing the bunkers.

(5) The ship must be given an ample ammunition endurance.



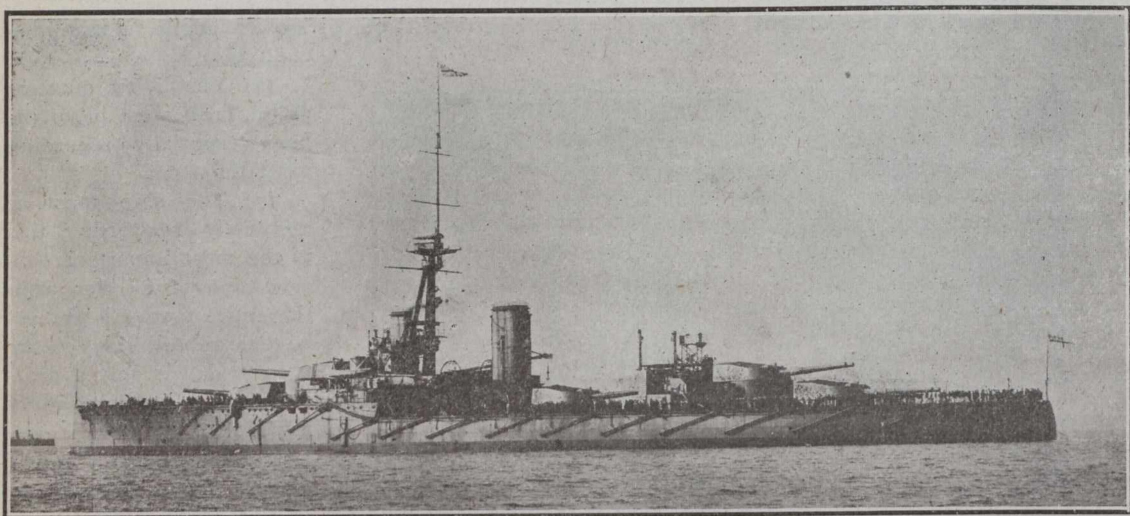
A Battery of Twelve-inch Guns and Their Fire Control Station in the Rear.

(6) The living quarters of the crew must be of the best, especially regarding sanitation.

(7) The ship must be absolutely seaworthy; this is the most important consideration of all, for after the entire matter is threshed out a battleship of the present day is only a floating foundation for heavy guns.

The naval designer has a difficult task before him when he attempts to reconcile all the foregoing conditions in the design of an ideal ship, as they are of such a contradictory nature, and if a battleship of given tonnage were armed more heavily than any ship previously afloat, the additional weight imposed by guns and mountings would have to be saved in some other point—in armor, for instance. The result of such a design would give a ship of great aggressive powers, but exceedingly limited in its own powers of resistance. If unusual speed is desired this involves increases in engine room, increased boiler space, and increased coal storage to maintain the steaming requisitions of the design. As the total tonnage is a given factor it follows that when one phase of the ship is made abnormal some other phase must be weakened; just which factor he may best reduce and in what manner the reduction may best be brought about are a few of the problems that the naval architect must contend. Some of these problems, however, solve themselves; an example will make this clear.

The battleships of the "Admiral" class which were much in vogue during the early eighties, were a type of ship that the admiralty hoped could be developed by enlargement in every detail as time and other conditions warranted; consequently this development continued until guns of 16¼-inch bore were mounted. It has been suggested that the corresponding increase in hull design was not thoroughly understood for of the three ships mounting these ponderous weapons, only one is on the sea to-day; this is the "Benbow." The fate of the "Victoria" is known to history, and the other member, the "Sans Pariel," is on the scrap heap. It was readily seen that development along this line was not practical, for the guns had a weight of 110 tons each, and this, added to their mountings, made the ship top-heavy, and then, again, this gun only possessed a muzzle energy equal to 2,087 foot-tons. The introduction of improved explosives and gun manufacture, which followed soon after the completion of these ships, resulted in an increase of efficiency of smaller guns, and in this manner the gun weight was reduced almost 50 per cent., with an increase of "smashing power."



H.M.S. "Orion,"
one of the most powerful battleships afloat.

The British warship differs from all other type of fighting ship in the degree of all-round fighting qualities. It is not so fast as a cruiser, and does not need speed; the object of a British warship is to get at the enemy, and not to run away.

Some few years ago, there was not such a marked line of separation between the battleship and the cruisers as now exists between the ships of the Dreadnought type and the modern cruiser. H.M.S. "King Edward VII." is probably the foremost example of a pre-dreadnought type of British warship, and yet the original "Dreadnought," though only 1,550 tons larger than the "King Edward VII.," has about 60 per cent. more smashing power and 33 per cent. more capacity of resistance, while several of the latest Dreadnought types could double these rates of increase.

With this rapid increase of power comes the rapid increase in the process of obsolescence, and twenty years is now regarded as the extreme maximum period of usefulness of a modern battleship; this short expanse of time is a marked contrast to the days of Nelson and his old wooden ships, for the "Victory" was fifty years of age when she entered the battle of Trafalgar, in 1805, and still floats in Portsmouth harbor, doing formal duty as the flag ship of the commander-in-chief of Portsmouth.

The primary business of the battleship is clearly indicated by the design, and the title and the work expected from a battleship squadron does not differ to any great extent, excepting the increased strength of the compound over the unit. It is a well understood axiom of modern sea warfare that however the course of the campaign may be influenced by brilliant desultory tactics, such as the guerilla attacks of cruisers and destroyers and such like, the great final issue may only be decided by the battle squadrons alone, and so long as they continue to float upon the sea the nation whose flag they bear is not beaten; when the battle squadrons are crushed the sea power of that nation is hopelessly broken.

Battleships form the first fighting line of all sea power. It is their duty to meet and engage, and all sea strategy is shaped to bring about this result on the most favorable terms. A meeting of hostile battleships may not of necessity be decisive, but when it is decisive and one side has no more effective battleships left, then the sea power of that nation is like the broken reed referred to in ancient history. The cruisers of a battleshipless nation may still manage to keep the sea and inflict serious damage to the commerce of the conqueror; and destroyers may make an occasional swoop with serious consequence, but the fact remains that without battleships organized sea warfare is at an end.

The power of the battleship then, depends upon its degree of gun fire and its resistance to hostile shells, and to maintain the latter condition the ship is armored; armor being a generic term embracing all the protective features of the ship. The principal heads under which the armor of a battleship may be classified are: (1) broadside protection; (2) armored bulkheads dividing the ship into watertight compartments; (3) protection of gun positions and all fighting stations, and (4) the protective deck.

The broadside armor is by far the most important feature in the defensive arrangements of any warship. It means the protection of engines, boilers and magazines against the direct impact of projectiles delivered broadside which, of course, presents the largest area of target to the guns of an enemy. In the modern designs the armor is carried from end to end and the greatest thickness is maintained along the central section which encloses the magazines and propulsion mechanism, the extremities are fairly thin. In a ship of the Dreadnought type this belt of armor is composed of a strip of Krupp steel, 11 inches in the thickest part and tapering to 6 inches at the forward end and 4 inches thick at the stern. A very much wider area of armor plate is always disposed below the water line than above; the belt being carried downwards to a depth of ten feet. Experience has shown that the high velocity projectile of a modern naval rifle, on being fired at a sufficient angle of depression to strike a ship well below the surface, either rebounds or becomes acutely deflected on touching the water. If the protective belt is carried to a depth of ten feet from the displacement line the chances of a ship being pierced from below are negligible.

The rapid improvement of naval guns rendered it imperative that the invulnerability of armor should be increased without a relative increase in weight; the Harvey process was the first step in this direction, but nearly all the British ships of to-day are armored with Krupp steel, which has a tensile strength of almost 50 tons per square inch, and is hardened by small injections of nickel, chromium and manganese. The Krupp plate, in its shell resistance qualities, has a figure of merit of about 2.5 as against 1.25 for compound armor which was supplied on armored ships built previous to 1890. The compound armor consists of a wrought iron plate attached artificially to a steel face of about half its own thickness; the result being a plate with the hardness of steel and the toughness of wrought iron on the back, the combination being designed to break a shell up without cracking the armor plate. Thus it is seen that the 11-inch belt of a modern Dreadnought ship offers more resistance to hostile gun fire than the 20-inch belt of the "Trafalgar" (a ship that was considered a wonder when commissioned in 1887) and this is accomplished with a reduction of about 47 per cent. in the weight.

In a modern British battleship a second section of broadside armor is carried above the belt mentioned above and is meant to protect the citadel or redoubt. This belt is carried upward from the midship section as high as the level of the main deck and is composed of 11 inches of Krupp steel in the centre tapering to 8 inches at the extremities; it encloses the turret mountings and the upper portions of the coal bunkers. All the main armor and the lower part of the upper belt is backed by a solid wall of coal nine feet thick.

The armored bulkheads subdivide the ship transversely into sections and these spaces are again subdivided by a central fore-and-aft bulkhead below the armored deck. In the Dreadnought type of British battleship the armored transverse bulkheads below the main deck—which is nine feet above the water line—are all unpierced excepting by pipes and wires and ingress and egress to these various compartments is effected by elevators.

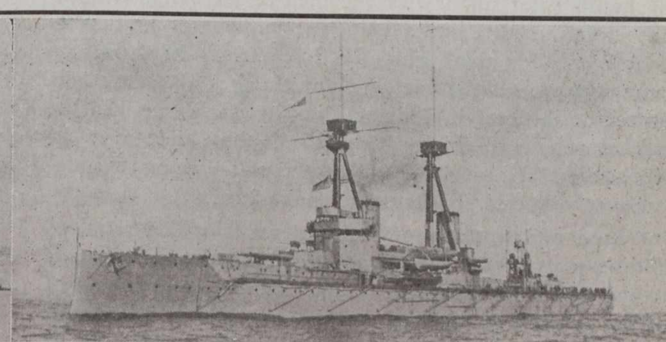
In the protection of guns the aim is to secure the maximum of safety for the crew and the firing mechanism, coupled with the greatest possible mobility in training the weapon over the widest possible arc of fire. The barbette, which is almost exclusively used in the protection of guns, is a circular fortress of steel with a bomb-proof top, the whole revolving upon a shaft which goes right down to the bed of the ship. (Fig. 1).

H.M.S. "Orion," considered to be the most powerful all-round fighting ship in service, mounts ten of the 13.5-inch gun of the new design. This gun weighs 76 tons and throws a projectile weighing 1,250 pounds with a muzzle velocity of 2,599 feet per second, and with the usual firing charge of 293 pounds of cordite is capable of penetrating 51¾ inches of wrought iron at a distance of 6,000 feet from the muzzle. It is reported that the admiralty have a still further improved 13.5-inch gun that has a muzzle velocity of 2,850 feet per second, and operates on a charge of 430 pounds of cordite without injury. This has not as yet been mounted, but according to report is an effective check against the proposed 14-inch gun mentioned in the estimates of certain foreign powers. The 12-inch gun, which we illustrate in Fig. 1, is the standard heavy British naval gun, and is mounted in nearly all the ships now in commission. This gun weighs 69 tons and throws a projectile of 850 pounds; the muzzle velocity of this weapon is 3,010 feet per second, and the extreme range is 25,000 yards, but its most dangerous range is given at 6,800 yards, at which point the velocity of the shell and its explosive properties harmonize to the best advantage.

A modern British Dreadnought carries 800 projectiles for these monsters, and the shell delivery apparatus is so arranged that one shot per minute could be flung from each gun. This rapidity of fire would not be feasible, however, owing to the eye-stinging vapors and the benumbing effect of the "back-blast" upon the crew. Guns of 10 inches, 9.2 inches, 7.5 inches and 6 inches are also disposed about the modern ship and all are considered large guns. The 4.7 and smaller weapons are regarded as "mosquito" armament, and are used only for close quarters, repelling torpedo craft, and by the marines when making land attacks.

H.M.S. "Invincible,"

one of a powerful line of battle cruisers that would keep the lines of commerce open during a time of hostilities, while the battleships were blockading the enemies' ports.



H.M.S. "Temeraire,"

one of many of Britain's latest Dreadnoughts. Note the tripod construction of the masts; they are constructed thus to allow great steadiness in the fire control tower situated half way up. Two legs of these supports could be shot away and the mast still remain rigid.

The fire control of each and every weapon on a modern British warship, excluding the hand rifles and officers' revolvers, is under the direct control of the gunnery officer in the fire control station. A series of electric wires and a switchboard enable him to communicate by telephone and other means with every gun turret on the ship. In order to reduce the risk of the fire control station from being shot away to the smallest possible limit, the fire control station is mounted on a steel tripod, each leg of which will effectively support the platform for a time, should the other two members become damaged. These tubes are hollow and the station may be reached by ladders secured to the inner surface.

The cost of a modern super-Dreadnought may be taken as follows:—

Hull	$2,386,000
Boilers and machinery	2,000,000
Searchlights and electrical fittings	400,000
Boats	40,000
Armor plate	3,240,000
Five barbettes and ten guns	3,000,000
Secondary armament of six-inch guns	400,000
Five torpedo tubes	200,000
Total	$11,666,000

PLANT EQUIPMENT.*

By F. E. Ellis.†

A score of years ago road building was a very simple business, requiring only a small amount of plant and very little expense was incurred by anyone who wanted to enter into it, and one in the business could withdraw from it at any time without sustaining a great loss due to the amount of capital tied up in the plant. During the last twenty years, the method of road building has gradually changed, until the plant now required by a contractor is large and varied, and the expense attached thereto is enormously large in proportion to the amount of work done per year.

It has become a business in which one should not enter without considering thoroughly the kind and amount of equipment required to do the work that he is contemplating, and only after a careful estimate has been made of the expense of plant and the proportionate charges that should be made for the same upon the work on which he is bidding. One must also realize that once in the business, he must remain in it for many years in order to get back the cost of his equipment, or else be willing to take a loss on the sale of it upon retiring. In other words, it is not a business that a man should enter upon with the idea of its being temporary, but with the idea of its being permanent. Failure to understand or obey this principle has been disastrous to many contractors. If the proper plant charges are not made, the contractor is deceiving himself just as surely as did the kind old lady who gave gingerbread to all the children in the neighborhood, and thought it did not cost anything because she had everything in the house to make it of.

The kind and amount of equipment which is required for building a road will vary in the different classes of roads to be constructed, and in order to make a correct estimate of the cost of equipment and the expenses incidental thereto, it is necessary to know the class of road which is to be built. For example, I am going to show you just what it actually costs to equip a road with proper construction plant. The road built was six miles in length, and surfaced with local stone grouted with bituminous binder. The stone was obtained from a quarry which was situated so that the average haul was about two miles. The whole contract amounted to $60,000.00. A contract of this size is considered an average season's work for one gang of men and one set of equipment. I am going to omit from these calculations the cost of small tools, such as picks, shovels and scrapers, and confine myself to larger items of wagons and machinery. The total cost of equipment was $18,240.00 or 30 per cent. of the contract price. The interest on the cost of equipment at 6 per cent. and depreciation at 10 per cent. per year makes a total of $2,918.40 for fixed charges on equipment, necessary to do $60,000 of work per year, or approximately 5 per cent. of the amount of the contract. Most of the expense of equipment was chargeable only to a few items in the contract which included the surfacing. The contract price for these items amounted to approximately $32,000. The first cost of the equipment used in the work covered by these items was $16,445 or 51 per cent. of the work done. The interest and depreciation upon the same amounted to $2,631.20, or 8.2 per cent. of the amount of the work done.

This I believe to be a fair estimate of the amount of equipment and the charges which should be made in order to be safe in estimating upon work of this character. There is hardly any business conducted in which the investment for equipment is so large and the expense due to depreciation and upkeep so great as in road building. Every engineer and contractor in making estimates ought to take these charges into consideration, and contractors who expect to go into the road building business, should make a careful estimate of the amount of plant required and the expense attached thereto. It is not a business in which a man can expect, in these days of keen competition, to make enough profit to pay for a plant in one season's work, and a man entering upon this kind of work must expect to stay in the business a long time before the equipment can be paid for out of the earnings. Road building machinery should only be purchased after a thorough investigation, especially in regard to the liability of breakdown and the expense of the up-keep. The expense of repairs on road building machinery is very small in comparison with the loss which is occasioned by the disorganizing of working crews due to breakdowns. In deciding upon the purchase of machinery, too much weight should not be given to the item of first cost, as the more expensive machine in first cost may be a far cheaper machine to operate and may be depended upon to do its work day in and day out, where a cheaper machine, although it may not break down, is very liable to do so.

In this discussion of road building equipment, I am not going to make any recommendation. I do not expect that my remarks will meet with the full approval of any of the machinery men or the contractors. We all know that if a man purchases an automobile that whatever kind he purchases, be it a one-lunger or a six-sixty, that particular kind is the only automobile worthy of consideration, and it can travel more miles per day than any other make, with less gasoline and expense of up-keep, and the same views are taken by a man who purchases road building machinery. I am therefore only going to give you my own views, which are the result of personal experience.

Wagons.—Four kinds of wagons have been largely used upon road work. The four-wheeled bottom dumping wagon, the four-wheeled two-horse tip cart, the two-wheeled one-horse tip cart and the four-wheeled slat wagon. The slat wagon offers no advantages over the other type, except they are a little lower and easier to load. This advantage is altogether outweighed when the time lost in dumping and turning around is taken into consideration. The single horse tip cart is very economical on short hauls and for work in contracted space, and for making end and side dumps on embankments, or in hauling stone from the quarry to the crusher. The four-wheeled tip cart hauls and is handled very easily on road work, but the weight being all on the hind wheels it is very destructive to road surface and subgrade, and much time is lost in dumping and righting the wagon. The bottom dump wagon can be used anywhere that the two-horse slat wagon or tip cart can be used, and is more economical than either, the expense of maintaining roadway being very much less than with the other kind. Material can be dumped more quickly, it not being necessary to stop while dumping, and the material can be distributed to a better advantage than with any other type of wagon. Any wagon used on road work should have tires not less than four inches wide.

Road Machines.—A road machine can be used to advantage in digging side ditches, scraping shoulders and making light cuts in the roadway. A machine for this purpose should be built strong enough to be hauled with a steam roller or traction engine without danger of breaking the machine, and also be equipped with a steering device, so that the machine may be worked outside of the travelled roadway

* From a paper read before ninth annual convention of American Road Builders' Association, held at Cincinnati, December, 1912.

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while the roller or traction engine is working upon the firm travelled way.

Stone Crushers.—Three types of stone crushers have been used to a great extent in road building—the gyratory type, the jaw type of the Blake pattern and the jaw crusher of the cam-shaft and roller type. The gyratory type is not very well adapted for portable plants on road work, as the crusher opening is so narrow that the stone requires too much sledging in order to properly feed to the crusher, and the crusher opening is so far above the ground that it requires either a pit or an extremely high dumping platform with a long incline in order to get the stone into the mouth of the crusher. They are also complicated and expensive to keep in repair for work in the eastern part of the country, as it is a long way from the source of supply of the repair parts. For permanent plants where the stone breaks well in blasting, they are a very economical machine.

The advantages of the Blake pattern are the extreme simplicity, there being a less number of reciprocating parts and a less number of bearings which require oiling, than in any other crusher. There is a wedge adjustment by which the crusher opening may be regulated without stopping the crusher. This is an important feature, where enough fine stone must be dumped along the shoulders of the road ahead of the bottom course, as in the case of grouted bituminous work. There is only one tension rod and one spring to keep in adjustment and repair. There are no bearings into which stone clips and dust are liable to enter. This type of crusher I have found to be very economical to maintain and is extremely reliable.

The disadvantages of this type are that for the same size opening, the crushers weigh more than the other type of jaw crushers. They are not so easily transported and handled, the situation and size of the fly wheels in reference to the crusher make it more unhandy to dump close to the crusher than any other type. As a rule the first cost is in excess of the other type of crusher.

The advantage of the cam shaft and roller type crusher is its light weight, which makes it easy to transport and set up, low fly wheels, situated so that the stone may be dumped much closer to the crusher opening than in the Blake type, low first cost and the quick delivery of repair parts. The disadvantages are that it is much more complicated; has more moving parts, more springs and tension rods, than the Blake type. There are more bearings to be lubricated, and the toggle lever shaft is generally situated so that chips and dirt can enter into the bearings. No adjustment can be made regulating the opening of the jaws without removing the toggle which can only be done by shutting down the crusher. Both crushers of the jaw type here mentioned will produce about the same amount of stone for the same size receiving opening and require about the same horse-power to run. All crushers should be fitted with manganese steel jaw plates, as experience has shown that these plates will last about three times as long as the first-class chilled iron plate, and are unbreakable, whereas the chilled iron plate may break or wear out in pockets after running a very short time.

Most all the crusher manufacturers make complete plants composed of bins, crushers, elevators and engines, which are mounted on wheels and can be loaded upon freight cars without being knocked down. Plants built in this style are very economical to handle and set up and are adapted to nearly all kinds of work requiring crushed stone. Where a traction engine is used for hauling stone away from the crusher, it is more economical to have larger bins and longer elevators than are generally furnished with a strictly portable outfit, as it is necessary to have storage capacity in the bins large enough to load a train of traction cars without waiting for the stone to be crushed. On a good many of these portable outfits, the screen plates and elevator buckets are made of too thin material to wear well, the elevator buckets wearing and rusting away quite rapidly. Unless specially ordered the sprocket wheels and gears are usually made of cast iron. The small sprocket wheels and beveled gears, I think, should be made of manganese steel.

Crusher Engines.—Crusher engines should always be large enough to have a surplus of power over and above that which is ordinarily required to run the crushing plant, and the boiler should have additional capacity large enough to supply steam for a steam drill, as in a great many cases, if this is not done, an additional boiler will have to be provided. Most of the states have laws which govern the construction and inspection of boilers, and in the states that have no laws now regulating the construction of boilers, the question is being agitated and undoubtedly in a few years there will be such in most of the states, and as road building has become quite an interstate business, and the machinery is transported from one state to another, care should be taken to procure a boiler which will pass state inspection. I believe that any boiler which is built in accordance with the Massachusetts standard can be used in other states, but there are many boilers which can be used in other states which cannot be used in Massachusetts. Plants equipped with boilers built to the Massachusetts standard, will cost more than boilers usually furnished with crushing plants. These remarks apply as well to road rollers, or any boilers.

Hauling Engines.—Where there is enough work to keep a hauling engine busy and suitable provision can be made for loading and unloading quickly, a hauling engine may be used to advantage, and is about 50 per cent. cheaper than hauling with horses. There is still an opportunity for improvement in hauling engines, especially in regard to gearing and traction wheels, most of the makers using cast steel gears that are uncut and very rough, and which wear very quickly. They also use a built-up riveted or bolted wheel with rolled steel rim. These wheels are generally a source of trouble, as the spokes get loose and break where the travelling is rough and stony, as it is on most construction work.

Road Rollers.—There is no class of machinery used in road building in which there is so wide a difference in construction and design and first cost as in the steam rollers. They may be obtained in most any shape or size or design that can be thought of. I think that it is generally conceded by road builders, and it has been my own experience, that a double cylinder steam road roller is better adapted for road construction than any other type. There is no class of road building machinery which has been so highly developed. The wide variation in first cost of the different steam rollers makes it very difficult for a contractor or town official to make up his mind which one ought to be purchased. There is almost as much difference in road rollers as there is in watches. You may purchase a watch for a dollar which is liable to keep good time for a year and it is liable not to do so. You may purchase a watch which costs almost any price, and in every case you will probably get just what you pay for. As a general thing, the higher the price up to a certain limit, the more dependable the watch is, and the same rule applies to road rollers. There is no road building machinery sold, that I know of, upon which an exorbitant profit is being made. In looking over a road roller with the view of purchasing, particular attention should be given to an investigation of the gearing and wheels. You can tell by the looks of the wheels and gears upon the machine which has been in use, whether or not that machine is going to do your work day in and day out as it ought to. A set of rear wheels should last, under ordinary service, at least ten years. I have wheels which have been in service fourteen years and are good, I think, for one more. The gearing on steam rollers should be of steel and cut and fitted as nicely as in any high-class automobile construction. Gears should be closed so as to exclude dust.

This paper might be extended indefinitely, going through all the different kinds of machinery required for the different kinds of road work, but I am going to conclude, as I have touched upon the equipment that is common to all road construction, whether it be water-bound macadam, bituminous macadam or concrete.

THE V-NOTCH WEIR METHOD OF MEASURING WATER.*

By Robert Yarnall.†

Attempts to measure accurately and to record automatically the flow of water through pipes or channels have been made from time to time with varying results as to accuracy and convenience. This paper will attempt to show results obtained by the simple and practical V-notch method of measurement, which though not new, seems now to be meeting with marked success, both abroad and in America, in power plant measuring problems. Tests of the accuracy of this method of measurement have recently been made in America and the data collected are here presented to show the degree of accuracy attainable.

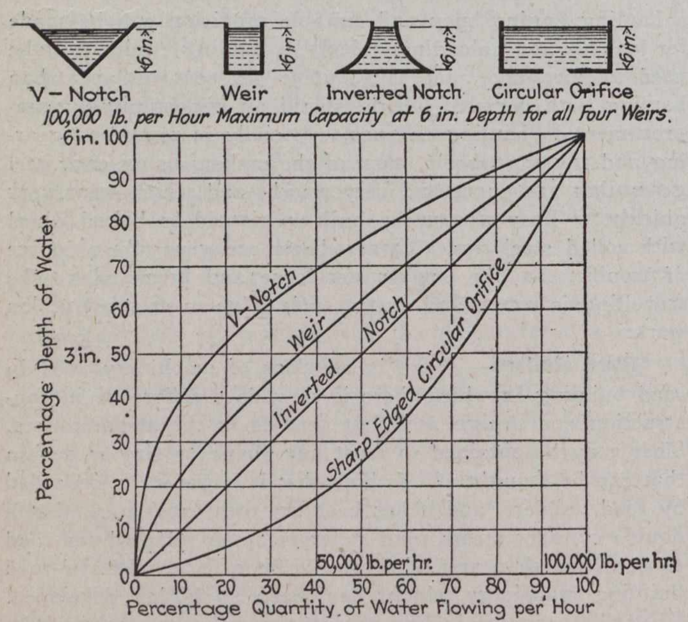

Fig. 1.—Curves Showing Comparative Accuracy of Different Types of Weirs Under Different Rates of Flow.

The instrument employed in the tests is the Lea V-notch recorder, an apparatus which depends on the laws governing the flow of water through weirs. These laws have been found to work with extraordinary accuracy, but it is only comparatively recently that they have been turned to account in measuring the widely varying rates of flow, both hot and cold, met with in power plants.

The most common forms of weir are the plain horizontal sill and the sharp edged rectangular notch. The former of these has the full width of the stream or channel and is without end contraction, the formula used in connection with it being that of Francis:

$$\text{cubic feet per second} = 3.33 \ LH \sqrt{H}$$

where

L = The width of the weir in feet.

H = The head of water passing over it in feet.

The latter is a sharp edged rectangular notch of less width than the channel or stream and therefore has end contraction. The formula used in this case is

$$\text{cubic feet per second} = 3.33 \ LH \sqrt{H} \times C$$

where

L and H are the same as before.

C = a constant which depends on the ratio of the width of the weir to the width of the channel.

Although these two formulas give a fair degree of accuracy, there is another in which the accuracy is very nearly 100 per cent. This is Prof. James Thomson's formula for the sharp edged V-notch weir:

$$\text{cubic feet per minute} = 0.305 \ H^2 \sqrt{H}$$

where

H = The height of the notch in inches, the angle of the notch being 90°.

Table I. gives the flow of water through 90° V-notches for each inch of head, up to and including 15 in., calculated by Thomson's formula.

Table I.—Flow Through 90° V-Notch Weirs.

Depth in notch, in.	Flow per hour, lb.	Depth in notch, in.	Flow per hour, lb.
1	1,140	9	277,900
2	6,480	10	361,740
3	17,830	11	459,030
4	36,610	12	568,720
5	63,940	13	694,710
6	100,860	14	836,110
7	148,290	15	993,510
8	207,060		

The section of the flow through the V-notch is at all times the same shape, though the area may vary, and this constancy of form tends to simplify the formula and make it accurate. This form of notch is also especially adapted for measuring smaller quantities of water than the rectangular weirs, as shown by the curves in Fig. 1, which give a comparison of the accuracy of the different types of weirs at different rates of flow. Another property of the notch is that its angle may be less than 90° without impairing its efficiency, which enables it to be used to measure very small quantities of water.

It was for these reasons, as well as for its accuracy, that the V-notch was adopted for use in connection with the Lea recorder, a sectional view of which is shown in Fig. 2. It will be seen that a float spindle, rigidly attached to a float which rides on the surface of the water flowing over the V-notch, passes up through the bottom of the instrument case. A rack on this spindle engages a small pinion upon the axis of a drum revolving between centres. Upon the body of the drum is a screw thread, the contour of which is the "curve of flow" for the V-notch in connection with which the recorder is used, and as the flow through the notch increases rapidly with the depth, the pitch of the screw increases in the same proportion. Above this drum is a horizontal slider bar, supported on small pivoted rollers and carrying an arm, at the upper end of which is a pen or pencil point in contact with a paper chart upon a clock-driven recording drum, which revolves once in 24 hours. As the float rises or falls the drum spiral is rotated, and its motion

*From a paper read before the American Society of Mechanical Engineers at its annual meeting in New York City, December, 1912.

†Mechanical Engineer Yarnall-Waring Co., 1109 Locust St., Philadelphia, Penn.

is imparted to the slider bar and pen arm by means of a saddle arm projecting from the latter and engaging at its lower end with the screw thread. On the body of the spiral drum is a graduated scale adjacent to the screw thread and computed in pounds per hour. It is thus seen that the drum serves the double purpose of rectifying the motion of the pen so that it moves equal distances for equal increments in the rate of flow, and of providing a magnified scale for making an accurate observation of the rate of flow at any moment.

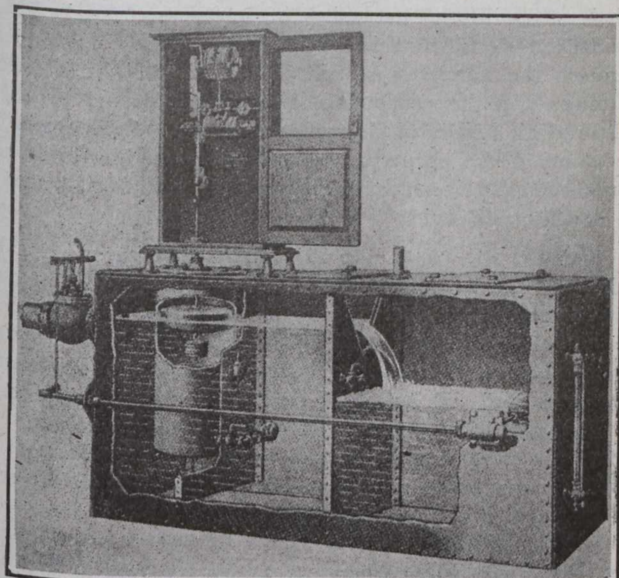

Fig. 2.—Sectional View of V-Notch Weir Meter with Lea Recording Mechanism.

The apparatus has the following advantages:

a. It is simple and hence dependable.

b. Its operation is continuous.

c. There are no moving parts in contact with the flow except the float which is in a chamber by itself and not in the path of the flow.

d. Collections of sediment and deposits of scale do not affect the accuracy.

e. Owing to change of density of the liquid being measured, due to changes in temperature, the float which actuates the recorder is immersed more or less, depending upon this change of density, and the recorder and the float are so constructed that they compensate automatically for these changes in temperature over a wide range.

f. By making the tank of ample proportions a considerable interval of time takes place between changes in the head on the weir, so that the recording apparatus has a chance to adjust itself to changes in the rate of flow, thus giving a chart very easy to measure with the planimeter.

g. It is always placed on suction side of pump, hence it is available at all times for inspection, cleaning and repairs.

Like the Venturi meter and the Pitot tube, the V-notch recorder is a continuous flow meter, but unlike these it is not dependent for its accuracy on velocity changes, and hence its record is not subject to the fluctuations due to sudden changes of velocity head observed in these meters while measuring rapidly changing rates of flow. Perhaps the greatest advantage of this method of measurement is found, however, in the way by which it may be checked independently of the recording mechanism. The operator may construct alongside of his recorder an independent "hook" gauge or use the graduated vertical scale and pointer on the extended float rod in the instrument, and can observe from time to time the number of inches head on the weir. By substituting these values in Thomson's formula, the rates of flow as shown on the recorder chart may be checked quickly and accurately. Thus the operator need not depend upon the recorded result until he is sure that it agrees with the

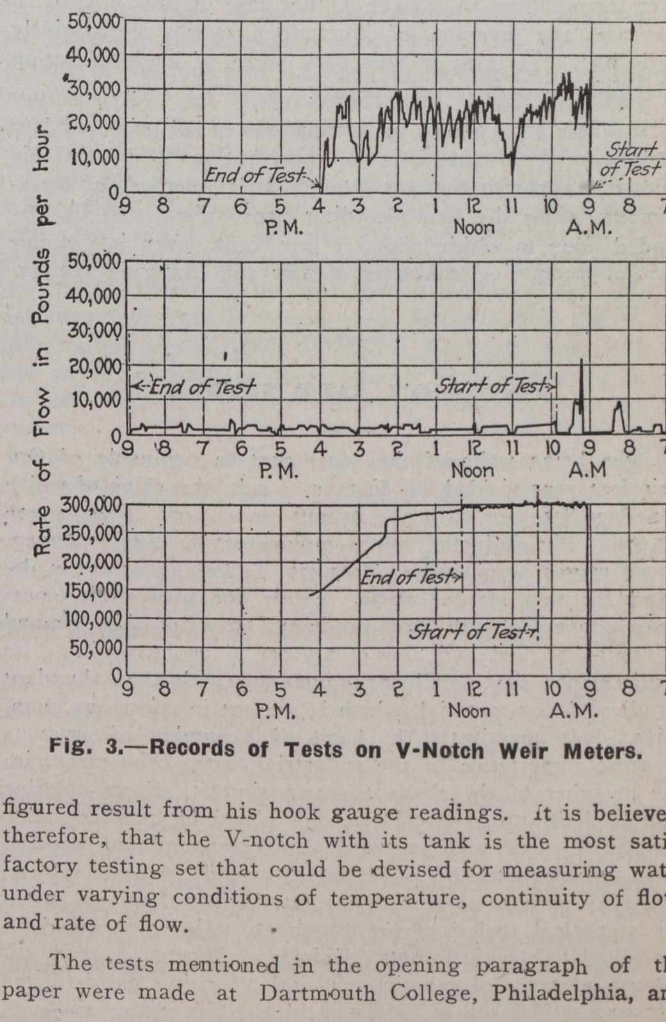

Fig. 3.—Records of Tests on V-Notch Weir Meters.

figured result from his hook gauge readings. It is believed, therefore, that the V-notch with its tank is the most satisfactory testing set that could be devised for measuring water under varying conditions of temperature, continuity of flow, and rate of flow.

The tests mentioned in the opening paragraph of the paper were made at Dartmouth College, Philadelphia, and

Table II.—Results of Tests on V-Notch Weir Meters.

Location	Dartmouth,	Col.	Phila.	New York City.				
Date (1912)	3-23	8-2	8-9	4-19	4-20	4-22	4-23	4-24
Duration of test (hr.)	6.25	10.2	1.96	5	8	13	8	8
Temperature of water (F.)	Var. 160°-195°	Var. 160°-195°	Var. 72°-74°	......	......	......	......	......
Corrected weight of water by tank (lb.)	143,841	41,625	596,867	291,965	266,009	557,974	352,725	352,725
Corrected weight of water by meter (lb.)	145,538	413,957	602,270	290,525	267,260	557,775	351,501	352,231
Error of meter (lb.)	+1697	—229.3	+5403	—1440	+1251	—199	—1224	—494
% error of meter	+1.18	— 0.55	+ 0.9	— 0.49	+ 0.46	— 0.03	— 0.34	— 0.14

— = low reading. + = high reading.

New York City. At the first location there were two tests, one in the winter and one in the summer, conducted by the engineers of the college, Messrs. R. D. Kimball Co. The graphic charts of these two tests are shown in Fig. 3, where the top chart shows the record of the winter test, the middle chart that of the summer test, while the record of the Philadelphia test is given in the lowest chart.

The winter test at Dartmouth College was made at the normal running load and took care of all the natural fluctuations in the returns from the heating system, which was being taxed to its utmost by an outside temperature only slightly above zero. These fluctuations were due in part to poor control of the return water from the heating pipes at the new Gymnasium, and in part to the small water-storage capacity of the receiver. The summer test was later run with the same apparatus as the first test, but the rate of flow and amount of fluctuation were greatly reduced because the Gymnasium heating system was out of service. The Philadelphia test was made with water of considerably lower temperature and much higher rate of flow. Also in this case the amount of fluctuation was comparatively negligible. The tests at New York were of longer duration and employed a meter of the larger capacity used.

In Table II. is shown the comparison of the principal data obtained in these three sets of observations and from this table it is apparent that the V-notch weir method of measurement, using the Lea recording mechanism, can be depended upon to within about 1 per cent., even in extreme cases of fluctuating character of flow and changing temperature.

ONTARIO'S SALT SUPPLY.

The brine wells of the south-western peninsula of Ontario last year yielded 88,689 tons of salt, the value of which was $430,835. In 1910 the output was 84,071 tons, worth 414,978. The industry gave employment to 216 workmen, whose wages amounted to $121,477. There is a steady demand for this staple article, mainly for preservative purposes connected with food products, etc., but this demand is easily satisfied and does not seem to be increasing. Its requirements are small in comparison with the abundant supplies of raw material, which is present in enormous quantities. Salt constitutes the basis of a number of products of great importance in the industrial arts, connected with one or other of the elements composing it. From chlorine may be built up hydrochloric acid, bleaching powder and a variety of other articles, while the compounds of sodium, such as carbonate and bi-carbonate of soda, sodium nitrate, etc., play perhaps even a larger part in manufactures, states the statistical review of the Bureau of Mines, compiled by Mr. T. W. Gibson, Deputy Minister of Mines. A plant for the manufacture of caustic soda and bleaching powder from salt was established at Sandwich by the Canadian Salt Company, and began operations during the last week of 1911. Some inquiry has also been made on behalf of a European firm of explosives manufacturers as to the availability of salt supplies required for the sodium nitrate used in making their product, which is finding a market in the mines at Cobalt.

About one-half of the salt made in Ontario is produced by the Canadian Salt Company, whose plants are at Windsor and Sandwich. Other makers are the Dominion Salt Company, Sarnia; Western Canada Flour Mills Company, Goderich; John Ransford, Stapleton; Ontario People's Salt and Soda Company, Kincardine.

The workmen employed at the salt wells and works numbered 216, and their wages amounted to $121,477.

SKYSCRAPERS ARE MONEY-LOSERS.

Mr. Purdy, president of the Department of Taxes and Assessment, New York City, spoke as follows of high buildings while in Canada lately, before the Canadian Club of Toronto.

Rising out of the present-day tendency to tax land fully, Mr. Purdy said, had come the tendency intensified to put real estate to that use which would make it yield the greatest financial return, but as yet the cities of this continent have failed to realize the necessity of protecting men's liberty against the license of their neighbor—hence the "skyscraper." Through the failure to restrict both the height of office buildings and the proportion of ground covered by them, light and air had been shut off to the extent of depreciating the value of the properties in the district, while high land values had also been localized in an extremely small area of the down-town district.

Preserve Air Space.—In his official capacity, the speaker had sat at the hearing of some 50,000 applications for lower assessment, and the number of these which were based on the loss of light and air through the disproportionate height of buildings in relation to surface area was astounding. Closely packed tall buildings had resulted in discomfort to the occupants, which caused them to forsake them, and the appeal for lowered taxation had followed. He further attributed to the intense congestion brought about by the erection of such structures, the smallness of the business area where land values are really high. At one point on Broadway, he explained, corner lots 25 by 100 feet in area are worth over one million dollars, while less than 100 yards distant are similar lots which would not command $25,000. "Had we restricted the height of buildings as did the cities of Europe," he declared, "we would have no $25,000 lots, no three-quarters of our business people working by artificial light during the day time, and no streets so crowded that at lunch and supper time it is practically impossible to walk in the opposite direction from the crowd."

As a preventive, he recommended legislation controlling both the height of buildings and the percentage of the lot which they may cover, in order that air spaces may be left between them.

"May I commend you," he continued, "here in this great growing city, which is still in such a position that you can regulate it in time, to look at the pictures of German cities, and to read their building regulations. They are restricting building from the standpoint of utility on the principle that no building may be allowed which will prevent others of the same size around it from receiving their share of light and air."

He further stated that he had recently had opportunity to talk to those who have erected one after another of the recent skyscrapers in New York, and not one of them has made money. Other arguments may not be effective, but perhaps this statement may give pause to some of those who wish to rush you into the erection of large office buildings which are to be the highest in the British Empire.

More Intensive Use of Land.—"With an increase of the tax on land has been an increase in the endeavor to use land for the most intensive purposes," the speaker continued. "Most European countries have recognized that it is necessary to impose the most stringent rules to regulate the height of buildings, and the area of land to be used for office buildings. Both the United States and Canada have been backward in imposing such regulations. They have been loath to impose regulations which would hamper the individual, but perhaps they have overlooked the fact that the freedom of the individual is bounded by the freedom of others, and that no individual should be permitted to do those things which interfere with the rights to light and health of his neighbors.

Restriction Injures City.—"The city of New York has suffered by this false idea. The limit to the erection of buildings has reduced the value of adjacent properties as a result of this license. We have ruined the appearance of the city, and impaired the health of its citizens, only to reduce the number of its suitable office buildings. Also, we have rendered it practically impossible to get any commensurate value from a great number of lots which are surrounded by these buildings of great height which have shut off their neighbors from light and air which they require.

"German and English cities have enforced ordinances which it would be well for American and Canadian cities to copy. The fact of the matter is that so far as New York is concerned, we have allowed ourselves to reach a condition which is without remedy. I speak now of the Borough of Manhattan. We can still help outlying boroughs, and you have opportunity to help a city which is growing logically and sensibly, but which you should not permit to depend for growth on artificial means."

PRACTICES OF THE WORLD'S BANKS

BY M. P. LANGSTAFF, A.I.A., F.A.S.

As has been the rule, the rate of discount announced by the Bank of England from time to time serves as a guide to the other banks throughout England and Scotland in fixing their rates for loans and deposits. It is, indeed, in a position to compel other banks to raise their rates to the same extent; for, should the London joint stock banks, for example, continue lending at a lower rate, the Bank of England would proceed to borrow all floating money that could be found on the security of consols, and thus create a vacuum, which could be filled only by money from foreign countries.

The Bank of England is the banker of the Government; is the largest issuers of notes, issuing its notes when required in exchange for gold bullion and paying notes in gold coin; and, being the bankers' bank, the weekly returns as to its position form the best possible barometer of the state of trade and credit in the country.

London has often been referred to as the clearing house of the world; for here many of the largest traders make their settlements; here the world's supply of gold finds its natural point of distribution; and here, England herself makes her great loans of capital. The Bank of England, therefore, is the centre of a great system of joint stock and private banks doing an immense cosmopolitan business. These banks keep their chief reserves in the Bank of England, which necessarily, therefore, occupies a position of great responsibility. From the peculiar nature of the business done by these banks, it follows that their liabilities are affected by numerous and sometimes unexpected conditions, whether in England or in any foreign country of importance, and hence they must often find themselves subject to great and sudden demands, which react, of necessity, upon the Bank of England, in which they keep the major part of their reserves. It is seen, therefore, that the Bank of England holds in its charge that on which the solvency of the banks in general, the safety of the commercial public, and the credit of England alike depend.

It has been said that in Scotland credit has been systematized to the last degree, and in this connection it will not be out of place to refer to their system of "cash credits." These, while not directly affecting the money market, perhaps, have yet from the fact that they have played an important part in the development of agriculture in Scotland, tended to affect it in their reactionary and future results.

When a borrower obtains a cash credit from the bank he is permitted to draw money as it is wanted up to a certain sum, being charged interest only for the time and on the amount actually used. As a cash credit is not based upon any completed commercial transaction, it is in reality "accommodation paper." For this reason adequate personal security in addition to that of the borrower is required, the bank thus advancing the loan on its knowledge of the character of the borrower and of the responsibility of his endorsers. Owing to this system, many young men of ambition and character have been enabled to attempt praiseworthy enterprises without the necessity of waiting long years to accumulate money from their own earnings.

If we consider the vast number of securities discounted by the Bank of France and their small average amounts, it must be at once apparent that the bank is a lender on a large scale to the class of small traders. One reason for this is that the bank discounts a great deal of paper on which advances have already been made by the banking house, which are the immediate customers of the bank.

Owing to the policy of the bank in lending in this way to intermediaries, and also direct to the small borrowers themselves, these latter are enabled to derive much advantage from the relief afforded by the maintenance of a fair rate of interest due to this flow of loans at a steady rate from the bank. The bank has also found by experience that the business carried on with the class of small traders is singularly free from loss and generally steady in its movement. Owing therefore, to this class of business, and also to the advantage that it enjoys as a debtor, under the bimetallic system of the Latin Union, the Bank of France has become in specie holdings the strongest bank in the world, and is less affected in times of financial stringency than any other bank.

I have referred before to the elasticity allowed to the Reichsbank in its note issue. Owing to this "elastic limit" it is enabled in a time of financial stringency, when the demand for loans is imperative and the market rate is high, to meet the necessities of borrowers, aud thus quiet the public mind.

Like the Bank of England, the Reichsbank holds a large percentage of the reserves of the other banks. As a consequence, the German banking world is dependent upon it in the event of any extrtaordinary demand. Occupying, as it does. the central position in the German money market, the Reichsbank finds it necessary to be ever on its guard against the dangers of the depletion of its reserve; and a diminution of this reserve is not only regarded with concern by the banking world, but becomes a matter for general uneasiness from the fact that this reserve is regarded as a most important resource for the Empire in time of war. Like the Bank of England, the Reichsbank regulates this reserve by varying its rate of discount, and, as a general rule, seems to have experienced less difficulty than the Bank of England in bringing the outside rates of the general money market up to a close approximate of its own rates.

Under the operation of the reserve system the cash reserves of the national banks are centred in New York. The great structure of bank credit in the United States, resting as it does in a large measure upon the money reserves of the New York banks, has been analogized to an inverted pyramid upon its apex. Financial conditions throughout the whole country are affected by every important fluctuation in the New York money market; and, similarly, the New York money market is affected by every change of any consequence in the demand for money or credit in any part of the country

Great economy in the use of money is the result of the central reserve system, the use of which, however, in the

United States seems attended by certain dangers; but the reasons for these may be assigned to other features of the United States banking system, among which may be mentioned the dominance of speculative influences in the New York money market, the independent Treasury system, and rigidity of the bank note issues.

To the fact that Canadian banks refuse to encourage speculation to any extent whatever may be assigned the comparative steadiness of the Canadian stock markets.

I have before referred to the tendency towards equalization of the rates of interest in all parts of the Dominion, due largely to the branch system and freedom of note issues of the Canadian banks.

THE RATIONAL USE OF WATER IN IRRIGATION.*

Dr. John A. Widstoe.

To all who have dipped ever so little into the history of irrigation, the annual meetings of this Congress appear of great importance. Irrigation is one of the great world-movements for subduing the "waste places" of the earth, and also for solving many of the social problems that perplex mankind. It is not impossible that upon irrigated lands, with their possible small family units, and their fertile soils and abundant sunshine, shall be formulated by actual experience the social ideals that eventually may bring the nations with their legions of human hearts into co-operative peace. This Congress is the only organized body which assumes general interest in all the methods, purposes and results of irrigation.

From its humble beginning in this city, modern American irrigation has grown, until the census of 1909 reports nearly 14,000,000 acres of irrigated lands. One-half of this vast area was brought under irrigation since 1899, and three-fourths since 1889. That is to say, during the last twenty years, three-fourths of the irrigated lands were reclaimed; while only one-fourth was brought under irrigation during the first forty-two years after the entrance of the Utah pioneers into the Great Salt Lake Valley. Clearly, the efforts of the country in behalf of irrigation have increased in geometrical ratio. This interest appears to continue undiminished, so that it can only be a matter of comparatively short time until most of the irrigation waters of the West shall have been brought upon the lands.

There are three main stages in the development of an irrigation project. First, the construction of satisfactory dams and canals in which the water may be stored and then led upon the land; second, the settlement upon the reclaimed land of a sufficient number of people to make full use of the opportunities of the project; and third, the correct use, by the settlers, of the water and land so that the project may be highly and permanently profitable. While these three stages are of equal necessary importance, yet it is evident that the first two, construction and settlement, once accomplished, are practically forever done, but the third, the use of the water, is of annual recurrence, and in the end will determine the success or failure of the project.

This third stage, the use of water, has been given least systematic attention; but with the increasing population under irrigation, it is insistently clamoring for attention. In the arid and semi-arid region, irrigation, under present methods of use, can probably never reclaim more than one-tenth to one-fifth of the total area of tillable land. For our 14,000,000 acres of irrigated land there are at least 500,000,000 acres that must be reclaimed, if reclaimed at all, by other methods. There will always be more land than water in the arid region; and one of the chief concerns of every project should be to cover profitably the largest possible area. The actuating spirit of irrigation enterprise is, or should be, to make possible happy homes for the many.

With this thought in mind let me call your attention to two vital principles of irrigation success. First, the beginning of irrigation wisdom is the conservation of the natural precipitation, i.e., the rain and the snow. Irrigation is not a primary art; it should always be supplementary to the natural precipitation, and should only make up for the deficiency in the rainfall. The progress of dry-farming during the last decade has brought this truth home to the irrigated section. The water which falls from the heavens, even under an annual precipitation of ten inches, is amply sufficient to produce crops, could it only be fully held in the soil. By properly conserving the rain and snow-water in the soil by dry-farming methods, large crops may be grown with small quantities of irrigation water. This is well brought out in a series of experiments conducted during the last ten years at the Utah Experiment Station.

Table No. 1—The Crop-producing Power of the Natural Precipitation.

Yields per acre.	Inches of irrigation water used. None.	5.0 to 7.5.	Per cent. of yield due to rainfall.
Wheat (bush. of grain)....	39	47	84%
Oats (bush. of grain).....	55	64	86%
Corn (bush. of grain).....	44	54	81%
Wheat (pounds of straw)..	3,934	4,526	86%
Oats (pounds of straw)...	2,233	2,274	98%
Corn (pounds of stover)...	3,228	3,888	83%
Alfalfa (tons of hay)......	5,540	7,178	77%
Potatoes (bushels)	97	145	67%

The data in the above table show that approximately 85 per cent. of the yields, under irrigation conditions, of wheat, oats and barley, 77 per cent. of the yield of alfalfa and 67 per cent. of the yield of potatoes, was due to the natural precipitation stored in the soil. This is only a fair sample of what may be done on any irrigated farm if careful soil tillage be practised. If, now, by careful tillage the natural water had been allowed to escape into the air, much more irrigation water would have been required to produce the crops. By the proper storage of the rain and snowfall in the soil, alone, it is possible to extend our irrigated 14,000,000 acres considerably. Therefore, to make our irrigation projects of greater service, the settlers upon them must be taught that irrigation is designed only to supplement the natural precipitation.

Second, the yield of any crop under irrigation is not in proportion to the quantity of water applied. The more water is used in irrigating a crop, the less yield is obtained per unit of water. This has been amply demonstrated also in the long continued investigations at the Utah Station, already referred to. As examples, note the following results obtained with wheat and sugar beets:—

Table No. 2—Inches of Irrigation Water Applied.

	5	10	15	20	30	50
Wheat (bush. grain per acre)............	38	44	46	47	49	49
Wheat (lbs. straw per acre)...............	2,986	3,452	3,954	4,311	4,755	5,332
Sugar beets (tons per acre)...............	14	19	20	21	21	24
Wheat (bush. grain per acre-inch).......	7.56	4.35	3.05	1.86	1.39	0.99
Wheat (lbs. straw per acre-inch).........	597	345	264	172	136	107
Sugar beets (tons per acre-inch).........	2.76	1.86	1.30	1.06	0.69	0.49

As the water increases, the yield becomes relatively smaller, and if enough water is applied, there is an actual diminution of yield. The studies of the United States Irrigation Investigations under Drs. Mead and Fortier have shown that excessively large quantities of irrigation water are used in ordinary practice. The losses which the irrigated

* Abstract of address before the twentieth National Irrigation Congress, Salt Lake City, Utah.

section has thereby sustained will probably never be known, but unquestionably run annually into millions of dollars.

It is of higher importance than ever before that a reasonable duty of water be established, and that those responsible for irrigation projects, by the education of the farmers as well as by the enforcement of reasonable rules, see to it that such duty is observed. At present, the duty of water assigned by the State Engineers is seldom as low as 30 acre-inches; usually, much higher. It will be a living question, in view of what we are learning concerning the relation between water and crops, whether even 30 acre-inches shall be allowed for one acre of land when it might be made to accomplish so much more if spread over a larger area.

Spreading 30 acre-inches of water over four instead of one acre, the increase in yield for wheat, corn, sugar beets and potatoes was threefold; for alfalfa even more, and for timothy twofold. Increasing foodstuffs in this manner, two and threefold, simply means that from two to three times as many human beings may be maintained upon the irrigated area; and every lover of the West dreams of the day when populous commonwealths shall cover the "Great American Desert." Irrigation is for the many, not for the few.

Table No. 3.—The Crop-producing Power of 30 Acre-inches When Applied to Different Areas of Land

Crop.	Thirty acre-inches spread over. 1 acre.	2 acres.	3 acres.	4 acres.
Wheat (bush. of grain)..	48	91	132	166
Corn (bush. of grain)...	97	188	269	317
Wheat (pounds of straw)	4,533	7,908	10,356	13,204
Corn (pounds of stover).	10,390	16,558	18,021	28,756
Timothy (pounds of hay)	6,054	7,688	11,739	11,928
Alfalfa (pounds of hay)..	8,840	15,093	29,653	....
Sugar beets (tons)	21	39	56	65
Potatoes (bushels)	195	373	456	544

By a more intelligent use of the waters already impounded or diverted the irrigated area may be increased largely, perhaps doubled. It is certainly a subject worthy of consideration. True, under the new projects, not yet well settled, there is no scarcity of water; yet in developing the West by irrigation should not the growth be symmetrical? We hope that no completed project will long remain without settlers; should we not be equally anxious that every new settler, from the beginning, use water the right way? In our older sections, water already is scarce; methods for increasing the duty are sought after; in time the newer sections will be in the same condition. Let us learn good habits in our youth, so that we shall have less to unlearn in our maturity.

FORESTERS IN DEMAND.

We note in the Conservation Publication for February an article which we publish herewith. It should be of importance to all those choosing future work and occupation.

The remarkable expansion of forestry work in Canada during the past year is evidenced by the fact that all the men who will finish forestry courses next spring at the University of Toronto were offered employment months in advance of their graduation. If the class were several times as large there would still be no difficulty in finding employment in Canada. The organization of the new Forests' Branch in the Department of Lands of British Columbia and the natural growth of work in the Dominion Forestry Branch, Department of the Interior, are largely responsible for this situation. At the present time the supply of Canadian foresters is far below the demand and this condition will continue for several years at least.

SOME FEATURES OF MACADAM CONSTRUCTION.*

By T. R. Agg.†

Inasmuch as water bound macadam has been written about and discussed so frequently, it would seem that there would be little need to consider it at a time like this. Nevertheless, it is not uncommon to see water bound roads under construction where little attempt is being made to observe the simple and well-known principles of such construction, and that is perhaps sufficient reason for some discussion of those principles at this time.

The well-known characteristics of a properly constructed water bound macadam road are: A well-drained, carefully shaped and thoroughly compacted subgrade; properly shaped side roads and ditches to insure the removal of surface water, and a layer of thoroughly compacted, properly bonded crushed stone, the surface of which has been well keyed together by rolling so that it presents a compact mass of stone of sufficient size to bear the loads that will pass over it without crushing and in which the stones are mechanically locked together by rolling and held in place by means of the dust from the crushed stone which has been worked into the interstices between the stones by means of water and rolling.

In deciding upon the size of the pieces of stone to be used for the upper layer of the water bound macadam road, two things must be taken into consideration—the quality of the stone which is available for use, and the amount of traffic and the weight and character of the loads which will pass over that surface. A road surface carrying a medium or light traffic, of which a small percentage consists of motor-driven vehicles, can obviously be made of smaller sized pieces of stone than a road surface carrying traffic made up of a great many heavily loaded horse-drawn vehicles, together with a large number of motor vehicles.

If the pieces of stone in the surface of the road are so small that the wheels passing over them crush them, it is inevitable that rapid wear will result and that the road will deteriorate quickly. On the other hand, if the surface of the road is made of very large pieces of stone, the traffic will not crush them, nor even wear them with sufficient rapidity to supply fine material to fill the interstices between the stones and keep the voids filled, notwithstanding the action of the elements and traffic. In such a case, the road will become rough and uneven, the surface being made up of rounded stones, which project slightly and make it disagreeable to traffic.

If the road carries any considerable proportion of motor vehicles, the water bound macadam does not prove satisfactory, but a surface made up of fairly large pieces of stone will withstand the action of motor traffic better than one made up of small stones, though the former is less desirable from the standpoint of the user on account of its roughness.

Somewhere between these two extremes, lies the ideal size of stone to use, which is a size sufficiently large to sustain the loads that pass over the road, without breaking, but small enough so that the wear on the surface will furnish sufficient fine material to keep the voids between the stones filled with dust and chips, thereby maintaining a smooth surface.

In the work of the Illinois Highway Commission, it has been found that with the soft limestone available, the size ranging from 2½ ins. to ¾ in., is most satisfactory. When stone of such a size is used it is, of course, desirable to have

* From a paper read before ninth annual convention of American Road Builders' Association, held at Cincinnati, December, 1912.

† Road Engineer, Illinois State Highway Commission.

the surface layer made up of fairly uniform pieces and to keep it free from pockets or patches of the finer material. This can be secured by harrowing the stone thoroughly, after it has been spread, by means of a heavy, stiff-toothed harrow. The harrowing not only brings the larger pieces of stone to the surface, but shakes down any pockets or patches of finer material that may occur.

The stone which is to be used for the wearing course in a water bound macadam, is, as has been mentioned, thoroughly locked together by means of the roller so as to form a closely knit surface. These stones are held in place by means of the mechanical interlocking resulting from rolling and by means of the stone dust and chips which are worked in between the larger pieces of stone by means of water and rolling. Eventually this finer material cements the stone together to form the wearing surface. A great many water bound macadam roads fail to give satisfaction because they were insufficiently rolled, and data collected in the construction of about 125 miles of 8-in. water bound macadam road in Illinois show that on limestone macadam there should be 0.04 of an hour of rolling per sq. yd. of finished macadam.

Most of the rolling should be done before any screenings are spread. If screenings are spread before the stone has been thoroughly rolled, they only serve to separate the larger stones. The resulting surface is made up of individual stones set in pockets of screenings and is not as durable as one made of stones firmly locked together by rolling before any screenings are spread. Moreover, if the screenings are rolled dry much the same result will be obtained. The screenings should be washed into the voids in the layer of stone and be allowed to set before much rolling is done on them. After the stone layer has received about all the screenings that can be washed into it and these have set for a day or two, the surface should be finished by rolling and sprinkling.

The durability of the surface will be greatly enhanced if it is covered to a depth of about ¾ in. with a good bonding gravel. Such a gravel should range from ¾ in. down, and should obtain 75 per cent. of hard pebbles, the remainder being sandy loam. The hard pebbles will gradually work in between the stones of the surface and will add materially to the wearing properties. In addition, advantage will be taken of the tendency for colloidal silicates to form under such conditions, thereby effecting a better bond for the surface than could otherwise be obtained.

Development of the bituminous macadam road has been brought about because the wear of the water bound macadam results in a fine dust which is disagreeable alike to the occupants of vehicles using the road, and to those who live along it, and because roads are being used by an increasing number of motor cars which have the well-known effect of blowing away the dust from the road surface and leaving an insufficient amount to fill the interstices between the stone, thereby allowing the stone to become loosened from the surface. Moreover, the thrust of the tire wears the surface rapidly and dislodges any stone not securely bound into the surface.

Inasmuch as the construction of bituminous macadam roads has been brought about to overcome some of the deficiencies of the water bound macadam, it is fair to assume that in the construction of these bituminous macadam roads, all of the good features of the water bound macadam should be retained and these good features be supplemented by the treatment which gives the advantages of the bituminous surface.

The object to be attained in the use of the bituminous surface is to hold the finer material in between the larger stones in the surface of the road so as to prevent loosening of these surface stones and to furnish a coating on the top of the road metal so that the wear on the stones will be reduced to a minimum, thereby eliminating a large part of the dust nuisance. There is nothing in the problem of bituminous construction which would be an argument for a change in the size of the stone or in the general method followed in water bound macadam construction, provided that the results which are desired from the bituminous surfacing can be obtained without such changes. With these principles in mind, the Illinois Highway Commission has been constructing the bituminous macadam by following, with one or two exceptions, exactly the same methods that would be pursued in building a good water bound macadam road up to the point where the bituminous surface is added.

The foundation of the road is prepared as carefully and in exactly the same manner as for a water bound macadam. The crushed stone is placed on the roadbed in layers of a thickness which will permit it to be thoroughly compacted by means of the roller. Usually the roads have been made 8 ins. thick, 5 ins. of which is in the lower course of stone and 3 ins. in the upper course. It has long been the practice among some engineers to bond the lower course of a water bound macadam road, although the practice is not at all general. In the construction of bituminous macadam roads, however, the practice of bonding the lower course has been adopted. The upper course of stone is placed and rolled exactly as if it were the upper course of a water bound macadam, care being taken to key the stone together thoroughly by rolling so that the amount of voids in the surface will be reduced as low as possible and the stones will be well locked together.

If a road is being built of hard stone, such as trap rock or granite, the upper course might be built of smaller sized pieces than is the practice of the Illinois Highway Commission, which is to use the same size as for water bound macadam. But, in any case, it is not believed that bituminous macadam can be constructed by the penetration method successfully if the upper layer consists of pieces much less than those ranging in size from 1 in. to 1½ ins. If hard materials of this class are used, the screenings may be used in the bituminous construction also; the size ranging from ¾ in. to ½ in. being spread before the first spreading of bituminous compound, and the size ranging from ½ in. to ¼ in., free from dust, being used for the final dressing.

If the screenings obtained from the soft limestones are used in the bituminous construction, there will be so much dust present even after repeated screenings that the bituminous application will be seriously affected on account of the presence of dust which will prevent the adhesion and penetration of the binder. Moreover, the small particles of limestone possess such a small wearing value that they are practically worthless in building up a durable surface. For that reason, it is better practice to use two sizes of screened gravel in the bituminous construction, one size commonly known as binder gravel ranging from ¾ in. to ⅜ in., washed and carefully screened, and a size known as torpedo gravel, ranging from ⅜ in. to ¼ in., also carefully washed and screened. The gravel used consists of smooth, round or angular particles, very hard and clean.

After the stone for the upper course of the macadam has been rolled, the surface voids are partially filled with the binder gravel, which is whipped into the surface from shovels, and the entire roadway broomed carefully to work the gravel into the voids and remove the excess from the surface of the stone. The surface of the macadam is then treated with an application of about 1 gal. per sq. yd. of bituminous compound, the binder being spread upon the surface of the road with a special pressure spray apparatus designed by the Commission. This apparatus consists of a furnace tank wagon capable of withstanding an internal pressure of 100 lbs. per sq. in., equipped with a manhole for filling and a pipe at the rear for discharging. By means of air pressure on the tank the binder is forced out through a metal hose to an "L" shaped pipe nozzle arranged to discharge directly down onto the road surface. The nozzle is equipped with a steam jet which discharges through the orifice through which the bitumen flows. As a result, the binder is blown out in a fine spray and strikes the road surface with considerable force.

Great importance is placed upon the necessity for applying the binder under pressure so as to insure its being forced down into the voids in the surface of the road. At the same time, the spray blows away all dust or other fine material which would prevent adhesion to the stone. After the surface is covered with the binder, the macadam is rolled once over, with the roller wheels wet to prevent sticking. This rolling is simply to replace any stone that may have been disturbed in the course of applying the binder, and, after rolling, the surface is smooth and even for the subsequent treatment. After this rolling, the surface is sprinkled with the ¾-in. to ½-in. gravel, a small quantity only being used and the gravel being worked into the interstices between the stones with brushes, but a slight excess being used so that the pieces will project slightly above the level of the limestone of which the surface is composed.

This second spreading of gravel is again covered with a bituminous compound at the rate of about ½ to ¾ gal. per sq. yd. of surface, and after it is spread, the surface is immediately covered lightly with the torpedo gravel and rolled. The surface is then gone over with the third spreading of the bituminous binder, the quantity used depending upon the condition of the surface and varying considerably with the size and general quality and characteristics of the gravel used, but ordinarily amounting to from ¼ to ½ gal. per sq. yd. of surface. The surface is finally covered with torpedo gravel, rolled and opened to traffic. In the construction of roads in this way a layer of ¼ to ⅜ in. in thickness can be built up on the surface of the stone, this layer consisting of bituminous binder and hard pebbles, making a wearing surface which is of a mastic nature, and contains stone sufficiently hard to withstand a considerable amount of wear.

The action of traffic on such a road is to wedge down the gravel pebbles in between the limestone, forming a crust which is very hard and durable, and at the same time is smooth and affords an excellent foothold for horse-drawn vehicles and a very satisfactory surface for the use of automobile traffic. Usually the most satisfactory texture has been obtained in the surface of the road when the bituminous compound used is of such a nature that it "bleeds" or exudes during hot weather. A road built with such a compound works up into an excellent surface, but some attention must be given to it after the road is opened for traffic, as the "bleeding" will continue for two or three weeks or longer if the weather is hot. This "bleeding," however, causes no inconvenience if the road is kept under observation and covered lightly with gravel from time to time as is necessary.

It is essential in bituminous construction to have access to a laboratory equipped for the examination of bituminous materials if results are to be duplicated, and all materials used should be tested and the results recorded for guidance in future work. Moreover, the construction of bituminous roads requires supervision and workmanship of a high order.

There are many miles of road in the middle western states where of necessity water bound macadam must be built if the roads are to be improved at all in the near future, and there are also many roads that could well be improved with the bituminous macadam and thereby answer all requirements of traffic for many years. Either kind of road must be built with a due regard to a few simple but fundamental and oft-repeated principles which experience has taught are essential to success.

The following discussion then took place on the paper:

President Lewis.—I am glad, gentlemen, to have the author of this paper confirm what I have ventured to intimate in speaking to you at the opening session—that the day of the water bound macadam has not yet passed by any means. I congratulate you upon having had this subject so clearly and effectively presented.

R. A. Meeker (State Highway Engineer of New Jersey). —Mr. President and Gentlemen of the Convention,—I heartily agree with what Mr. Agg so truthfully said in his able paper—that little attempt is being made to observe the simple and well-known principles of macadam construction. While this to a certain extent is true there has arisen a demand for hard roads, and this demand in many cases has been so loud and long that every other quality requisite for a good road has been lost sight of.

It is true that macadam roads are dusty if neglected, but if properly maintained they are no more dusty than many other classes of pavement. Mark what I say—if properly maintained. The great trouble with the majority of road builders and the public at large is that they consider that if a road is once improved, that is the end of it, nothing more is necessary to be done, the road will take care of itself for all time. But the stone wears off, the fine screenings are ground into dust, and the impalpable dust is blown over into the neighboring fields. That is one ground of complaint in New Jersey that possibly is not troubling you people in the middle west. There are farmers and truck raisers who say that this dust depreciates the value of their crops, and particularly that of the smaller fruits. This to them is a serious matter.

If a water bound macadam road is well and properly taken care of and if material that is worn out by traffic is replaced with fresh material and not with dirt, your macadam road will not be objectionably dusty. Many and many a time have we seen a good macadam road covered with mud from the gutters. Of course, our gorge rises to a certain extent; and we get quite an unenviable reputation for kicking; and when they carry that abomination still further and deposit sods and grass upon a stone road words cannot express our feeling. A macadam road in perfect condition should contain not more than 21 per cent. of voids. This is not a guess; it is the result of a number of tests made of the material taken from many macadam roads that have been dug up and carefully analyzed. This density is almost impossible to obtain until after the road has passed through the first winter and spring. Then, if after the frost is out of the ground, the road is well and thoroughly rolled, and all the weak places that develop are strengthened, and the whole surface brought to a regular, uniform grade, the road will wear uniformly and form the best foundation for a future bituminous surface if the growth of traffic warrants the extra cost. This has been proven by years of experience. I would ask you gentlemen who have seen many macadam roads constructed—how many of them have you seen taken care of in the manner I have described? People seem to forget that the most critical period in the life of a stone road is, like that of a human being, during the first year of its life; and if the road is properly started and gets its proper consolidation the first year, it will last and wear until it is practically worn out. The ruts and dust and raveling of which we hear so much will not appear. Seventy per cent. of the roads in our country are off the through lines of travel. These can still be improved with crushed stone or gravel. If the increased travel causes dust to rise in such quantities that it is objectionable, one or two light applications of a true bitumen will lay it. Possibly I might define a true bitumen as one which contains no lubricating material. If an alleged bitumen contains lubricating material the condition of your road will be like that of the man in scripture out of whom the seven devils were cast.

Mr. Agg's practice of harrowing the stones to secure uniformity in size, while effective for soft limestone, would never do for our harder trap rock and dolomite. We fully agree with his statement that it is necessary to have the surface always made up of fairly uniform pieces and to keep it free from patches of finer material. We find the only way in which we can secure uniform surfaces is by grading the stone carefully before, not after, it is spread upon the subgrade. This method of harrowing is from an economic standpoint, in some sections, a very good thing. But our experience has taught us that it is almost impossible to properly grade the stone after it is placed upon the road. Therefore we insist that our quarrymen shall supply us stone in regularly graded sizes, and if the stone does not come in those properly graded sizes we refuse to accept it. All of our specifications in the State of New Jersey are drawn in that way. Thus, the contractor who signs the contract to build a road under our specifications makes a contract with the quarryman that he shall furnish him with specification stone. That contract is binding upon the quarryman as well as upon the contractor, and if he does not receive properly sized stone he simply refuses to accept them, and the quarryman does not get any money. Just as soon as a quarryman finds that he is working for love he sees a light and makes up his mind to the fact that it is better to do as he agreed to and not as he wishes to.

All that Mr. Agg said about the necessity of thorough wetting and rolling we most heartily indorse. It is impossible to build a good macadam road without the use of plenty of water. In finishing a macadam road we have found no better rule than that of the master road builder, Edward P. North, who said: "Wet your stone until a wave of mud forms in front of your roller." Miles of macadam road in Central Park for years tested the truth of this maxim. What Mr. Agg said about the wastefulness of rolling screenings dry we indorse. It is a point upon which we are very insistent; in fact, so insistent that our specifications expressly prescribe that no screenings shall be rolled dry. A macadam road, whether it is built of limestone, dolomite, trap rock, or granite, must be treated as concrete and to get good results with your concrete you must puddle it thoroughly. To get good results from a crushed stone road the surface must be thoroughly puddled until the water comes to the surface. In the earlier days of our practice we were severely criticized for putting too much water on the roads and making the roads and shoulders muddy. Afterwards when the road was finished nothing was said about it.

I notice a great many practical road builders here, and they will all agree with me that if you do a good job you hear nothing about it, but if you make one slip, what you hear is aplenty.

We have listened to many able papers upon the more expensive types of pavement. It has been our endeavor to avoid mention of these as far as possible, confining our remarks to those road coverings that can be most cheaply laid. Each section of the country has material at hand which may be used with great benefit upon its highways. Commissioner MacDonald puts a light coat of stone chips upon his gravel roads and obtains a very good road. We have also used this method with very satisfactory results. If the road builder in each section of the country carefully tests the materials he has at hand, he will find something that if properly applied will greatly improve the surface of his roads—crushed stone in a rocky region, gravel in another, and a mixture of sand and clay in another, till at last we reach the alluvial flats where the paving is done with burnt clay as demonstrated by the Office of Public Roads, and what was alleged to be impossible in road improvement is accomplished.

In New Jersey we have a greater variety of soils and rocks than have many of the other states. Commencing with the older rocks of the northern portion of the state, we run down the scale until we reach the sand and alluvial plains near our southern limits. Therefore, our experience is possibly more varied than that of many others. We found that the old assertion that trap rock is the best stone which can be used for a macadam road is subject to qualifications. On heavily travelled roads trap rock is the ideal stone for water bound macadam. In roads of medium or lighter traffic, we find that a dolomite, or one of the harder limestones gives far more satisfactory results, is less costly to prepare, and at the same time forms a harder and smoother surface. Hence we must not take the maxims laid down in the books without a grain of salt. You will find possibly, in your own section, material that will improve your highways to a wonderful degree. Proper location, proper grading, proper drainage, and proper construction, will always yield very good results.

We hear a great deal about the waste of money spent in improving roads. It is said: "What is the use, why should we issue bonds for the roads when they wear out in ten years and that which has cost so much will all be gone?" In our state we have built some roads that have cost us $50,000 a mile, but over $40,000 of that was for relocation and grading. Now, that did not wear out. That was not dissipated, but is a valuable asset. When you consider that a 10 per cent. grade requires the expenditure of as much power to traverse one mile of it as would be expended in travelling 6.3 miles on a level, you begin to realize the advantages to be derived from reducing the grades. In the old days they told us that it was a waste of money to grade, and on the old road surfaces this was to a certain extent true, because any load that you could haul through the muck and mud of the flat you could haul up the hard stone hills. Now, those conditions are changed. Upon a uniformly smooth surface it is possible for a team to haul from four to six times as much on the level as it could possibly haul up the same old hills; and if we are to derive the full value from our improved roads proper grading must be given the attention which is its due.

President Lewis.—Gentlemen, this subject is open for discussion from the floor. We will be glad to hear from anyone, and I know that the author of this paper will be glad to answer questions.

F. F. Rogers (Deputy State Highway Commissioner of Michigan).—I would like to ask Mr. Agg about how much he has found the increased cost of bituminous over the plain water bound macadam, also what kind of materials he used this year, and if they have proven satisfactory?

Mr. Agg.—I will answer your first question and say that the difference in cost between the water bound macadam and bituminous macadam in the Illinois work has been about 18 cents. per sq. yd. Now, as to the repairs, the commission has been conducting experiments on sections of roads throughout the state upon which they have been using some of practically every bituminous material which is on the market in Illinois; and it would be impossible to go into the results of all those experiments this afternoon. The commission will shortly publish a report in which will be given the results of three years of experimentation with bituminous compounds which have been used with about 20 or 30 different materials. If any of you would care to get that report and will write to the Illinois Highway Commission, Springfield, Illinois, I will be glad to see that you get a copy. In general I would say, however, that we have found that on the roads which are subject to a covering of sticky mud, pulling in from the side roads, which is a condition that is found in most of our roads, we found the various kinds of tar binders to be unsatisfactory. On the other hand, we have used on some roads which are not subjected to this action, tar binders which have given excellent results. We have also found binders which could be used on a road in a soil of an acid nature, the kind of soil we have in southern Illinois, and the same binder used on roads in the northern part of the state where the soil is alkaline or neutral, went to pieces very shortly. As I have said, we have an extensive series of experiments going through our laboratory, the results of which will be given later.

Mr. Rogers.—Just one other question as to the comparative results of hand pouring and pressure spraying?

Mr. Agg.—We used the hand pouring method for two years and then followed that by two years of the pressure method. It seems apparent to us that you cannot hope for satisfactory results in bituminous work by the hand pouring method. Occasionally a good road is constructed in that manner, but, in general, in our work we have found that about one road out of four constructed by the hand pouring method has proved satisfactory. This is due to the fact that inevitably the bituminous binder will be thicker in some places than it will be in others. When the road is put under traffic, this condition is not apparent, but as the road gradually wears, the traffic gradually compacts the surface, then the places where the binder is thick are seen as raised places in the road. The places between these high places being lower, the action of traffic is to increase this effect as time goes on. Some roads that were constructed by the hand pouring method three years ago had to be entirely resurfaced because the surface became irregular. The texture was all that could have been asked, but it was in this condition due to the effect of the binder put on in that way. We do not think that bituminous macadam can be put down by the hand pouring method. (Applause.)

John S. Gillespie (Road Commissioner, Allegheny County (Penn.) Road Department).—Mr. Chairman and Gentlemen: I am taking issue with Mr. Agg and our distinguished chairman in regard to the macadam road. It is something like a prescription. A prescription may cure one when it will not cure another. Macadam roads may be successful in some places, and not in others.

I have charge of the roads of Allegheny County, Penn., and some of you gentlemen have pamphlets showing what Allegheny County has done for good roads. We have at the present time in our county, 450 miles of improved roads. A year ago we had 360 miles of macadam, yet at the present time we have only 308. The reason for this is, up until September, we had about 60 miles of macadam road and we made the same into asphalt roads. Macadam roads are not a success, and have never been since the automobile came into existence. It may not make a difference in the East where Mr. Meeker is—I have been over a great many of his roads—they have the hard trap rock. We, in Allegheny County have the limestone, and most of that is shipped in from Ohio.

I am going to give you the specifications of our roads; and I don't think there is a macadam road built anywhere in the United States that is better built than we are building. Our macadam roads are built with 8 ins. of telford stone, thoroughly rolled and napped, and then we have the macadam top of 4 ins., giving us a 12-in. road. And yet they are not successful.

In regard to the dust, the limestone dust; we have that. We take care of that problem. I am not the father of good roads in Allegheny County, but I have been the mother of good roads for seven years; I have been taking care of them. We do all our own repair work. We have 14 road rollers and we have 14 gangs that are going all the time. Two years ago this summer I had charge of putting on 96,000 tons of stone in resurfacing our roads. We spend $1,500,000 a year on roads. You will notice by the pamphlet our valuation is high, the same amounting to $1,141,567,110, and there isn't much trouble for us to get money. We have plenty, and we can try anything that we want to that looks good. We have used oil. Five years ago this summer I came down to Cincinnati in company with our county commissioners. We went to Lexington and looked over their oiled roads. Last year we used 422,000 gals. of oil. We have not used less than 300,000 gals. of oil per year for the last five years. Now, I just tell you that to show you that we care for our roads. Not only that, but we have a patrol system in Allegheny County. We always have had it, ever since the first road was built. At the present time we have 110 caretakers. Each caretaker has between 3 and 4 miles of road to take care of. These men are hired by the year; they work every day, and are paid $55 a month. Their duty is to go along and keep the ditches and sewers open, and keep the weeds cut down. As you all know, weeds grow rapidly along a macadam road, especially a limestone road, because limestone is a great fertilizer.

Our experience is that macadam roads are no good. They are a good substitute. As Mr. Agg says, you have to fall back on the macadam. That is all right, but if you if you have the money you don't want to fall back on macadam. Now, some of you gentlemen have been to Allegheny County and seen our roads, and know that we have built them right, yet they do not stand.

In regard to putting down the macadam road, from practical experience this is what I found: The contractors do not build the roads, or put down macadam roads as we do, because it takes a little more time. I am going to tell you now how we bond our roads so that you will know whether or not we do it right. In putting our roads down we do much the same as the gentleman from Illinois; we put our stone down and thoroughly compact that. I found from experience that by using the larger stones we got the best results. You can go along a road and reach down, blindfolded, and pick up all the stone you can hold in your hand; probably there will be three or four pieces, and by pressing them together they will interlock, and that is why the larger stone is used. That is how the Romans built their roads, with the larger stones and of a uniform size. We roll that thoroughly, and I have taken 60 bushels of coal across the road just after the rolling and before any screenings were applied, and hardly made any impression on it. We roll the ballast well, and then we put on a slight sprinkling of screenings, and by the roller passing over the same two or three times it shakes the screenings down between the stone. Then we apply the water, thereby getting the road to bond from the bottom. We put on only a light coat of screenings, "feeding" it, as I say to the men, in order to get the proper bond. We then roll the same until we have a batter all over the road. We leave this then, and take the roller on to a new piece of 40 or 50 ft. Too much screenings has a tendency to "choke," giving you the necessary batter, but not the bond.

I might say that I have always found in putting down a macadam road that it is best not to take too long a stretch, because one of the most important points in building a road is the water. If your roller covers too great a distance, you do not get all the benefit of same as by the time the roller goes over the road a second time, the water has soaked into the foundation. I find you have to seesaw quickly to get the advantage of same. You must get the benefit of it before it enters the road.

In starting the new piece, the same methods are applied which I have just given. In a day or two the sun bleaches the road, causing white spots to appear. We then take the roller back and roll the same thoroughly. We then take the roller off and flush the macadam surface well with water, and we leave it. That flushing cements the road tight, and the result is, in a day or two we have a road with a hard, metallic ring. Now, that is the way we put our macadam roads down, so you can be the judges as to whether or not we put the same down right. I condemn it. A macadam road in certain seasons of the year, or certain winters, is better than others. In Allegheny County three years ago this winter, the independent ice companies did not get a single pound of ice. It would freeze a little at night, and thaw out in the morning.

Seven years ago, when I took charge of the roads in Allegheny County, I was conceited enough to think I knew a little about roads. Things I advocated then, I condemn now. Then the macadam road was good, but we have a different traffic to-day. The automobile has come in and it has come to stay. Even those who say macadam roads are good, find fault and say they can't take care of the automobile.

As I was going to say, where you have an open winter, the frost goes into the macadam, and in leaving the same in the spring it disturbs the bond, making the road "green." During this period you can watch a heavily loaded wagon go along and rut your road. Now, if you could only close your road in the spring when the frost is coming out, could close it entirely to traffic, the elements would rebond it, but we can't close them and the roads get rutted. Now, gentlemen, that is my experience and my belief is that the macadam road is no good. I don't say they are no good everywhere, but they are no good in our county, nor in the western part of Pennsylvania. We can't get trap rock. A gentleman here at this convention told me that he could sell us trap rock, f.o.b. the boats at Cleveland for $1.50 to $1.60 per ton. Now, if we are to pay that price at Cleveland, together with the freight to the Pittsburg district, making a total of $2.25 to $2.50 per ton, it will be cheaper for us to adopt the mechanical mix or penetration. That is what we are doing. This summer we put down 17 miles of penetration and about 30 miles of the mechanical mix.

We have all kinds of roads in Allegheny County, we have the macadam road, brick road, rock asphalt, Warrenite and Amiesite, and we have all kinds of resurfacing work. The telford foundation of the first road constructed in our county is still there, we never lose the foundation and the second time a road is covered it is better than the first, even with macadam.

Will P. Blair (Secretary, National Paving Brick Manufacturers' Association).—There is just one suggestion that I want to make. It may not reach the point, but the last speaker has just stated that the greatest trouble they have with their macadam roads in Allegheny County is the fact that in the spring of the year and during light winters, where they are having constant freezing and thawing, the road gets into such a condition that it is easily rutted. Now, if the gentleman will permit what may seem to be a criticism of the way in which they build their roads, and leave their roads in that county, it will be given in the best of spirit, and I believe it may be of some assistance to them, and to all road builders. The condition of a great many roads in Allegheny County is this: The water is not carried from underneath the bed of the road to the ditches on the side of the road. That is the condition of a good many macadam roads in this country in the winter and spring. And that is the trouble with all kinds of roads unless you carry off the water or the moisture and let the air in, not by building a ditch along the side of the road, not by conveying the water from certain stream watering places on the road, where the water oozes out under the road, etc., not by carrying that down the middle of the road and into the side ditches, but by putting in cross tiling at right angles, across the roadbed, and getting that moisture immediately out and keeping your roadbed dry. If you keep your roadbed dry underneath, your moisture, or your temperature—your low temperature—is not going to disturb the aggregates and the condition of the road as found in the summer time. Keep it dry, and it is going to keep in place. That is just a suggestion.

Mr. Gillespie.—Just a minute, please, in answer to Mr. Blair. Gentlemen, I said that the first road built is still as good as ever; and that was built in 1897, showing that it isn't the foundation. We put French drains in every 50 ft. during the construction of our roads. I say that when our roads are resurfaced they are better than when first built. It is not the foundation that gives way, it is the top coat that blows away, the telford remains. The matter of drainage is well taken care of by the frequent use of these French drains.

COMBINED STEEL OUTPUT.

The combined output of steel in the United Kingdom, Germany and the United States in 1911 exceeded 45 million tons, whilst the world's output is estimated at between 59 and 60 million tons. A comparison of the approximate outputs of the chief producing countries shows that the United States produced in 1911, 23,676,000 tons, Germany 14,778,000 tons and the United Kingdom 6,565,000 tons. A noteworthy feature of the returns is the increase of about 24 per cent. in Germany's steel output, whereas that of the United Kingdom and the United States remains practically stationary.

POWER PRODUCTION COSTS.*

Cheaper generation in the near future is dependent on more efficient turbine plant, and the recovery of by-products from coal by the employment of gas fuel for firing boilers. The companies whose business is general supply, as contrasted with the special purpose power stations, might be expected to take fuller advantage of such tendencies. But in any case the margin for saving in costs of production must be substantial. When it is observed that a municipal plant such as that installed at Stockport, consisting entirely of reciprocating engines, can gain merited approbation for working costs of 0.56d. per unit on a load factor of 23.42 per cent.—a result as favorable as that achieved by Manchester, generating nearly twenty times the quantity and employing large turbines—it is clear that there is a large field for profitable study in this department. By the improved load factor resulting from more general and diversified demand numerous items of expenditure can be reduced in proportion to output while the coal costs may almost disappear when the full by-product value is realized.

*From Supplement to London Times.

The Canadian Engineer

ESTABLISHED 1893.

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CONTENTS OF THIS ISSUE.

The article on Storm Water Discharge, by R. O. Wynne-Roberts and T. Brockmann, will be concluded in next week's issue, March 13th.

FORESTRY AND IRRIGATION.

A great number of people do not realize to what extent the present efforts towards development of scientific and practical forestry will ultimately benefit irrigation. The extent to which it will simplify the work of engineers in the economic handling of water is often not understood. These benefits apply more particularly to our timbered provinces, but, in so far as most of the rivers of the prairie provinces have their sources in the forest lands, it applies to them, though not to the same extent, as well. British Columbia, however, on account of its topography and the great possibilities of irrigation in that country, ought to be more vitally interested than the other provinces in the proper understanding and practical working out of the relation of forestry to the making productive of its many large tracts of fertile land.

The aggregate of water power available in British Columbia is tremendous, and the province is only in its infancy as far as development and using that water for man's benefit goes. The greatest difficulty with northern mountainous countries re water courses is the variable flow of water. Summer's sun, even when there is no rain, produces such a melting of snow on the mountain tops, that the rivers are, many of them, in flood or high-water mark in August. In the same way, cold in winter reduces many streams to practically nil. This variation results in many a fine summer's waterfall being out of consideration, commercially, for power development purposes, but it is not so serious a drawback for irrigation purposes. Irrigation is only needed in the summer, and if a country can utilize its gushing summer streams for an increase of the productiveness of the land, the better are the people and the province. It is in the lessening of difficulties and expense for irrigation that forestry holds out promise to the people and engineers. Forests, as we all know, act as a protection to moist earth by keeping off the sun's rays. We have seen, for example, snow in our woods long after it has disappeared from the open places. The forests are partially a storage basin for the winter's moisture or for sudden rains. Strip British Columbia's hills of the forests and it would only aggravate the variable high and low water levels of its rivers, and there is a consequent increase in the costs when trying to properly control and distribute such water. Not only this, but the sun, after the forests are cleared and fires taken place, often bakes the surface hard, and rainfalls gathering on the surface rush down, scouring and gouging out earth in deep channels, and may possibly, by depositing unfertile mountain soil on lower productive lands, finally destroy the fertility of the good land itself. In short, clearing a mountain hillside bare of trees may just mean to the land below that, whereas formerly irrigation and fertile acres were possible, yet afterwards, thanks to the extra expense involved in controlling and suitably distributing the water under the new conditions, the whole plan becomes as a commercial proposition impossible.

This is not likely to happen often, but even if it does not make irrigation impossible, yet as a general rule one can state: "The more unconstant the feed of waters to lower levels due to mountains cleared of trees (either by lumbering or fire), the more increased the cost of handling that water for irrigation." Whether the irrigation is in the form of government work paid for by taxes or by rent to a water company, the people pay, and in the absolute destruction of forests the country is not only poorer by the loss of lumber, but indirectly by the added cost of land fertility.

British Columbia has not been asleep in its attention to its water rights and powers. Its Water Act of 1909 re irrigation was an improvement and an advance on all the laws of this continent. California was trying, and has possibly passed by now, legislation modelled after certain provisions in the Water Act of British Columbia. Canadians can take pride in seeing the leading irrigated state in the United States willing to learn off a province in its infancy as regards irrigation. Let us hope British Columbia meets with a fitting reward in the way of good results and prosperous people.

TWO GOVERNMENT INVESTIGATIONS

The United Shoe Machinery Company has had the doubtful pleasure of being investigated as an alleged combine by the governments both of Canada and of the United States. While nominally the companies are distinct, in reality the Canadian concern is a subsidiary of the Boston firm.

The matter received additional interest in view of the recent decision of the Supreme Court at Washington, which held, in effect, according to a despatch from that city, that the Sherman anti-trust law does not forbid the mere combining of non-competitors in an industry. The company was held to be a legal concern.

In Canada, two of the investigating boards concluded that the United Shoe Machinery Company of Canada was a combine. They reported on October 18th, 1912, their conclusions as follows:—

"Such advantages as are claimed by the company for its system of doing business, when they are not inconsistent with the existence of competition, are not vital to a consideration of whether competition is unduly restricted; neither are any complaints made by the manufacturers where the ground of these complaints would disappear if the way were open to competition.

"Eliminating from consideration all those elements of the relations between the company and its customers, we find that:—

"The United Shoe Machinery Company of Canada is a combine, and by the operation of the clauses of the leases, quoted in the foregoing, which restrict the use of the leased machines in the way therein set forth, competition in the manufacture, production, purchase, sale and supply of shoe machinery in Canada has been and is unduly restricted and prevented.

The representative of the company on the investigating board signed a minority report, stating that, while the facts established by the evidence submitted to the board were set out in the majority report, he differed with the other members of the board with the conclusions that were drawn from those facts. He thought that, considering the company's methods as a whole, they were not against public policy. The company, he added, had been of manifest advantage to the manufacturer of boots and shoes, to the labor operating the machines, and to the consumer.

Discussing the case against the United States company, District Attorney French, who had charge of the government case against the corporation, is reported as saying:—

"The question which has just been decided by the Supreme Court was merely one of criminal pleading. The great and important issue between the people of the United States and the United Shoe Machinery Company is whether or not the latter is a monopoly in violation of the Sherman act, and this depends largely, if not wholly, upon the view which the courts will ultimately take regarding the tying clauses in the leases, or, generally speaking, of the patent question involved. Upon these matters the court expressly declines to pass, apparently for the reason that they were not presented by the record, and says in effect that it must accept without question the interpretation of the lower court, which regarded the indictment as merely referring to the organization of the company, not to the 'tying clause' leases."

The strongest feature of the United States Government's effort to show an unlawful combination in restraint of trade, says Solicitor-General Bullitt for the Government, was the "tying" clause of the agreements, by which it is alleged that the company sought to compel shoe manufacturers to buy machines from it and none other. That question, he declared, was not considered by the court, because the lower court had interpreted the indictments involved in the latest decision as referring solely to the organization of the United Shoe Machinery Company.

The tying clauses were largely the bone of contention in the Canadian case. Mr. Winslow, president of the company, admitted in the Canadian investigation that the purpose of the tying clauses was to give the company that security by preventing the introduction of other machinery into the factory. He stated that if the company were obliged to remove the tying clauses from its leases a change in its system of doing business would be necessary. He was not able to state the basis on which the rates of royalty were calculated, these having been continued from the previous leases. He assigned no reason for the necessity of a change, nor did he indicate what that change would be.

No other evidence was adduced by the company to show what would be the nature of the changes to be made in its system if the tying clauses were eliminated, nor that changes would be necessary for the protection of its interests.

"As indicating that the object of the tying clauses," said the Canadian majority report, "is rather to prevent the introduction of competing machinery than to establish continuity of operation, it may be noted that the company's welter and stitcher will be leased to work in connection with other principal machines obtained from outside sources, that machines corresponding to the machines of the company's general department can be obtained from outside and introduced into the service, and that the company will sell the machines of the general department, in which event the company has not the same interest in keeping the machines in order as exists when machines are leased."

The Canadian investigators found the company to be a combine, and, as the six months' delay recommended and adopted, dates from October 18th, 1912, the company is liable to a penalty not exceeding $1,000 and costs for each day, after April 18th, 1913, during which the company continues to offend. The court procedure in Canada seems to have been far more simple than in the United States, where the government has not yet fired its final shot in the case.

EDITORIAL COMMENT.

We are pleased to be able to give in this week's issue a further summary of the discussion which took place at the recent annual meeting of the Canadian Society of Civil Engineers, held in Montreal, January 28th to 30th. It was impossible to cover this discussion fully in the limited amount of space at our disposal in the daily edition of *The Canadian Engineer*, which was issued in connection with that meeting. We are glad, however, that we have this opportunity of giving it now, and it will, no doubt, be read with a good deal of interest by not only the delegates who were in attendance at the convention, but by many other members of the society who were not able to be there.

THE MOOSE JAW WATER SUPPLY.

By P. Gillespie, B.A.Sc., A.M.Can.Soc.C.E.*

That portion of Alberta and Saskatchewan between the 54th parallel of latitude and the International Boundary comprises nearly 250,000 square miles. It is drained by the Saskatchewan and Assiniboine Rivers and contains not a single body of water as large even as Lake Simcoe. On a basis of only 20 persons to the square mile, this region would become the abode of five millions of people. The present population is something in excess of 800,000.

When we consider that the great centres of population in Europe—St. Petersburg, Christiania, London, Paris and Berlin—lie north of the 49th parallel of latitude, that the great migrations of history have been westward and northward, that Canada is the last great area awaiting the enterprise and energy of the pioneer, that while in point of population the United States of America stood 100 years ago where Canada stands to-day, her railway mileage was not until 1857 equal to that of the Canada of to-day, nor her foreign trade as great as that of this country at the present time until the year 1861, it will, I believe, be granted that the growth I anticipate is a very moderate one indeed, and that the problems consequent theron are really only beginning. One of these is that of water supply.

To the life-long resident of Ontario, with its fine series of inland and border streams and its magnificent chain of great lakes, this special problem of the western plains will scarcely appeal. In the prairie provinces, as indicated above, the scarcity of streams or lakes capable of serving large communities has rendered it both acute and unique.

The city of Moose Jaw, Sask., is situated on the main line of the Canadian Pacific Railway, some 420 miles west of Winnipeg, and 40 miles west of Regina, the provincial capital. In the language of the surveyor, it lies in Township 16, Range XXVI., West of the Third Meridian. Its present population is approximately 25,000, probably half of whom are dependent directly or indirectly upon railway operation and maintenance for a living. It is surrounded by an excellent agricultural district, and of late years has experienced a period of growth and prosperity which would be regarded as phenomenal in older districts. In consequence, it has outgrown many of its public services, including its water supply. Up to a few weeks ago this was obtained partly from a well in the city near the confluence of Thunder Creek and Moose Jaw Creek, which is fed by an infiltration gallery receiving water percolating from the creeks through the soil; and partly from Snowdy Springs, so-called, seven miles distant in a southwesterly direction, the supply flowing by gravity through a ten-inch wooden main. Two years ago a deep well was bored at a point adjacent to the present city power house in the hope of locating natural gas. On reaching a depth of some 1,200 feet the drilling was temporarily abandoned, a heavy flow of water having been encountered. This water is saline and by itself not potable. In cases of fire it was the custom to pump raw creek water and gas-well water into the distributing system, the subsequent draining of which by hand having been relied upon to free the mains from water unfit for domestic use. Of late years the supply has proved quite inadequate to the needs of the citizens, so much so, in fact, that at times water was available in the service pipes for an hour only three times a day.

In the spring of 1911 Mr. Walter J. Francis, C.E., of Montreal, was asked by the municipality of Moose Jaw to investigate the entire situation and advise as to a water supply from this western city. Mr. Francis began his investigation early in May. This involved a study of some ten suggested courses, most of which were found to be impossible because of one or more of three reasons, viz., insufficient quantity, unsatisfactory quality or prohibitive cost. Among the sources investigated were the Moose Jaw Creek, Last Mountain Lake, the Snowdy Springs, the South Saskatchewan River and Sandy Creek, all well-known to residents of Southern Saskatchewan. For the reasons indicated above, all were rejected for immediate development, save the last-mentioned—Sandy Creek—a stream near Caron, some 20 miles west of the city along the main line of the Canadian Pacific Railway.

Mr. Francis' report, in brief, suggested that the city proceed at once to concerve its then present supply by installing a separate high-pressure fire system in the business district. This would enable the city to cease using the limited domestic supply for such purposes as street watering, most manufacturing processes and fire-fighting. The city was also advised to proceed at once to make a thorough exploration of the valley of the Sandy Creek. The indications at the time the report was prepared were that there was available there one million gallons of water per day. If this, by subsequent investigation, should be confirmed, it would mean that this quantity, together with the supply at that time serving the city, would be sufficient for a city of 30,000 people. The ultimate source, it was obvious, must be the Saskatchewan River in event of the population very much exceeding the limit indicated. Moreover, if the Sandy Creek project were to be developed, much of the necessary installation would become a part of the Saskatchewan development, since both sources lie in the same direction from Moose Jaw. The expense involved in utilizing the Saskatchewan necessarily placed it beyond the immediate reach of any single municipality as far distant as Moose Jaw, but a suggestion was made that the city combine with other interests and prepare at once for the use of the Saskatchewan River water at a time not far in the future.

The city council of Moose Jaw, with characteristic western enterprise, immediately voted an appropriation for the investigation of Sandy Creek, which investigation was conducted during the summer months of 1911. Weirs were installed in eight different places on the creek, from which daily readings covering several months were obtained. A number of deep test wells were drilled in various places across the wide valley of the creek, revealing the presence of a lower supply of water (apparently separated from the upper by an impervious stratum of clay) whose analyses were markedly different from those of the surface water. The knowledge acquired during the exploration tended to confirm the earlier opinion as to quality and quantity, and Mr. Francis' firm, Walter J. Francis & Company, were authorized to proceed with the preparation of final plans and specifications and the supervision of the work. The contracts for the work were awarded during the early months of 1912 and construction was actually begun in April of that year. The water was in use in Moose Jaw before the end of November or within eight months.

The works consist of an infiltration or collecting gallery terminating in a main well over which is constructed a headworks pumping station, a pressure main, a headworks reservoir of 500,000 gallons capacity, a gravity main 96,200 feet long extending from Caron to Moose Jaw, a storage reservoir (in the city) of 2,000,000 gallons capacity, a second pumping station and an elevated tank.

The Infiltration Gallery.—The infiltration gallery will consist, when complete, of 4,000 lineal feet of 20-inch glazed tile, laid with semi-open joints in the water-bearing sand of the valley of Sandy Creek, at a depth of about 16 feet. Manholes are provided every 800 feet, or wherever changes in

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*Associate Professor of Applied Mechanics, University of Toronto.

direction occur. The invert of the pipe has a gradient of 0.4 per cent., and is approximately parallel with the natural surface of the ground in which it lies. The lower semi-circumference of each joint is sealed with a cotton sack filled with what was originally dry cement and sand. This is carefully placed in the invert of the bell when the pipe is laid. This sack adapts itself to the irregularities of the tile while still soft, and later on prevents the admission of sand to the pipe. The upper half of the joint is protected by a depth of one foot of graded gravel which, for the sake of economy, is confined in a cheaply constructed box of spruce lumber scribed to the curvature of the tile. This also prevents the entrance of sand into the interior of the pipe. It will be seen from this that the gallery is intended to drain the surface stream and that it may lower the level of the ground water down to, but not below, the axis of the pipe.

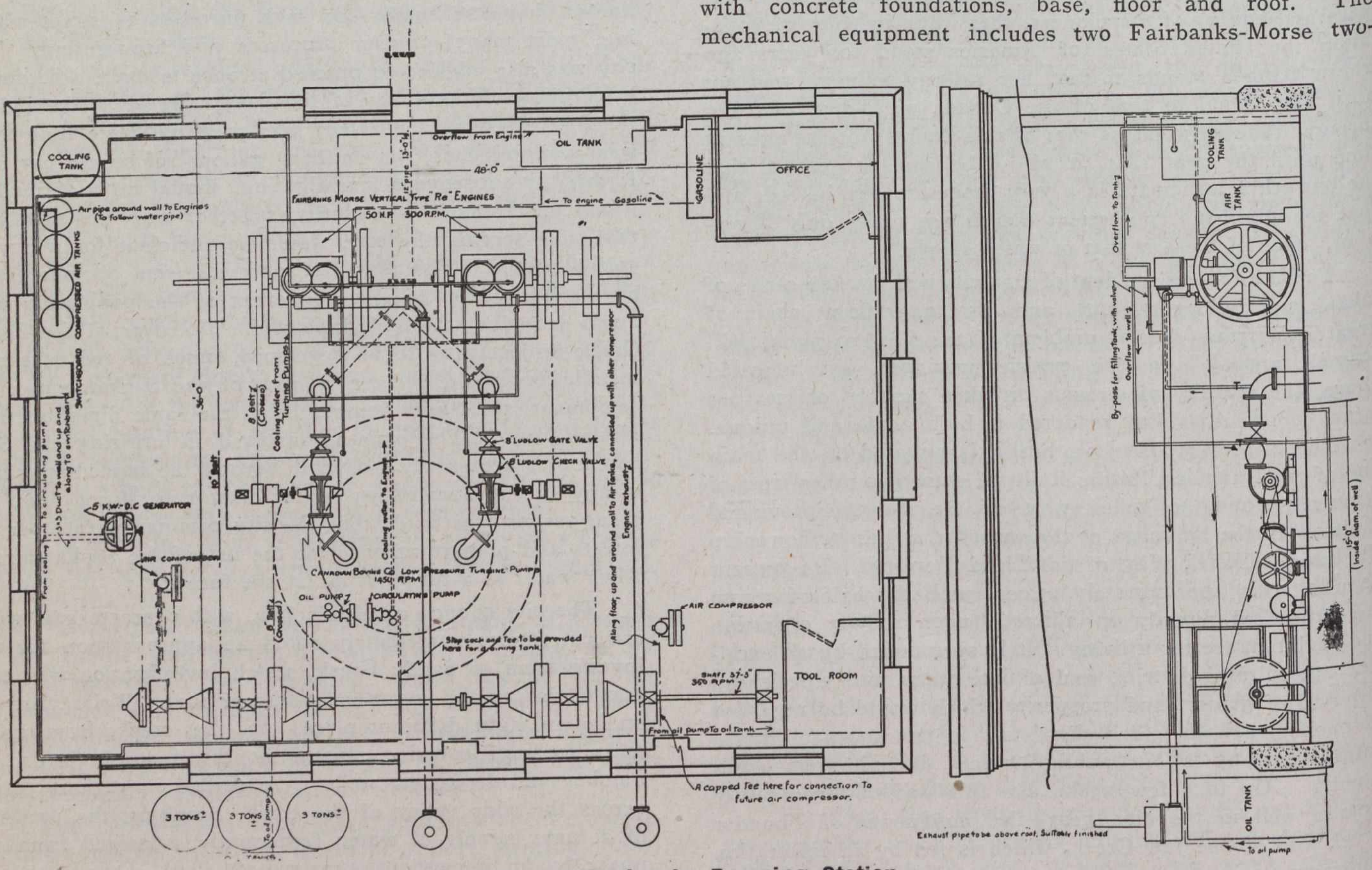

Fig. 1.—Headworks Pumping Station.

The laying of this gallery in a water-bearing gravel and quicksand presented some special difficulties. Two parallel rows of 9-inch United States Steel Company's interlocking steel sheet piling 18 feet long were driven one on either side of the proposed centre-line of the gallery and distant therefrom two feet. This was accomplished without special trouble with the aid of a 2¼-inch McKiernan-Terry pile hammer fitted with special driving cap, and by a liberal use of the water jet. The first six feet of depth of excavation was done by hand, after which a 6-inch Goulds centrifugal dredging pump was put into service and the remainder of the excavation done thereby, sufficient water to render this operation possible being meanwhile admitted to the pit from the creek above. Bulkheads and transverse shoring were placed as the work progressed. The pulling of the piles was accomplished by the aid of a Yale & Towne 3-ton triplex chain block for starting and an ordinary pair of triple blocks with a 1-inch fall and a steady team of horses for the rest of the operation. A generous application of axle grease to both bulb and channel sides of the pile during the driving greatly aided the pulling afterwards. The greatest difficulty met with was the prevention of water coming into the trench from underneath the piling, especially where the line led across lagoons, as it did in a portion of the work.

The infiltration gallery terminates at its lower extremity in a main well circular in plan, 15 feet in diameter and 29 feet deep, and constructed of concrete. An adjunct of this well is a valve chamber through which the water passes on its way to the well and admission to which from the gallery is controlled by a 16-inch gate valve operated from the floor above. This valve chamber is provided with a permanent metal weir enabling the operator at any time to determine the quantity of water being received from the gallery. The excavation for this well was done entirely by the dredging pump. Over the well stands the headworks pumping station.

Headworks Pumping Station.—The headworks pumping station is a brick structure, 48 x 36 feet in plan with concrete foundations, base, floor and roof. The mechanical equipment includes two Fairbanks-Morse two-cylinder, four-cycle, 50 h.p. vertical oil engines, belted through a line shaft to two Böving centrifugal pumps, each of 600 gallons per minute capacity. The arrangement is such that either or both pumps may be operated by either engine. The nominal speed of the engines is 300 r.p.m., and that of the pumps 1,450 r.p.m. The two discharge pipes join with the 18-inch pressure main in a special wye outside of and below the pumphouse wall. Each pump is protected by a check valve set in the discharge main and priming, when necessary, is done by a by-pass connecting the pressure main beyond this valve with the pump casing. In addition to the engines and pumps there is a 5 kw. generator for lighting purposes, an air compressor and air storage tanks for starting, and oil and water pumps for fuel and cooling respectively. Ultimately, when it is decided to install the deep wells for the purpose of obtaining the water in the low-lying strata of gravel, an air-lift equipment will be employed and the compressor capacity will be increased. Provision for such increase has been made in the lay-out of the station. The usual storage tanks for oil, gasoline and water are provided and complete the equipment.

The Pressure Main.—As stated elsewhere, the pressure main has a diameter of 18 inches. It consists of welded steel tubes of thickness ¼ inch and of average length 17 feet. The ends are plain and the joints are made by the Custer method. A sketch of this joint is shown herewith in Fig. 2. The joint mechanism consists of a collar sufficiently large in diameter to slip over the ends to be connected, two followers or gland rings, two rubber gaskets and ten track bolts. The collar is ten inches long and on its interior are two projecting buttons which insure half the collar covering each of the two ends to be connected. A special Custer wrench is used for tightening the bolts. The advantages of this joint are that it is slightly flexible after being laid, that it can be made under water, and that a change in direction equal to three degrees at each connection can be secured with 18-inch pipe. With 10-foot lengths it will be seen that a thirty-degree curve could be followed if necessary. Experience has shown that if proper care be taken in the jointing. Absolute watertightness can be secured. The specification for laying required that as soon as the pipe was connected up, backfilling to a depth of one foot over the pipe, carefully rammed, should be done. The objects of this were to avoid injury to the pipe in case of caving-in, and to prevent the pipe floating in wet situations where water could not enter the free or open ends of the pipe. Part of this pipe had to be laid at a depth of 14 feet and over, owing to the irregular nature of the ground through which it passed, and the advisability of avoiding summits in the profile of the pipe.

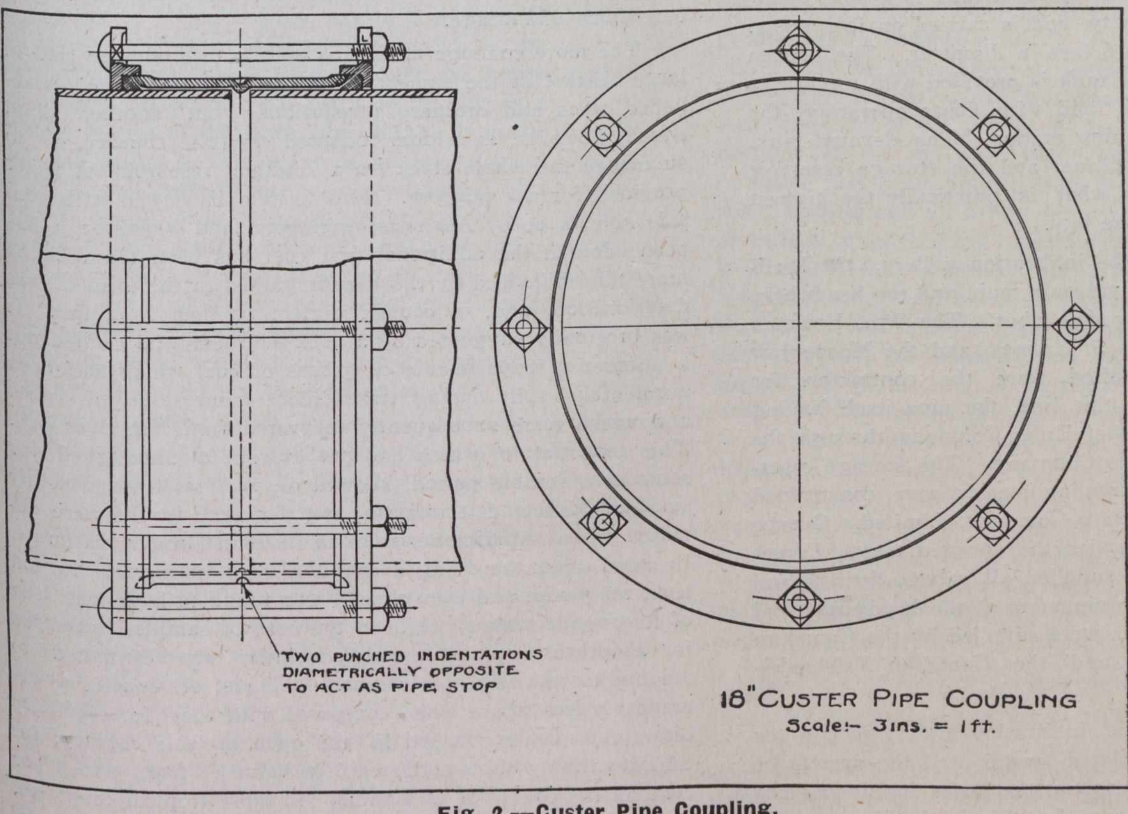

Fig. 2.—Custer Pipe Coupling.

Headworks Reservoir.—The headworks reservoir is an all-concrete structure circular in plan, 75 feet in diameter and holding, when full, 17 feet of water. The roof, which is of the girderless type, is supported by 9 columns placed in three rows of three each. Admission of water to the reservoir and discharge therefrom are controlled by 18-inch gate valves. The admission valve is protected by an 18-inch check valve. The roof is about 8 feet above the normal level of the ground. Backfilling against the exterior walls and over the roof slab adequately protects against frost. The concrete was the equivalent of a 1:2:4 mixture thoroughly well mixed and carefully tamped. No other waterproofing precaution was employed and when, after construction, the the reservoir was tested full for 24 hours a leakage of less than ¼ of 1 per cent. occurred. The difference in level between the normal water level in this reservoir and that of the storage reservoir at Moose Jaw is 57 feet. The infiltration gallery, headworks pumping station, pressure main, and headworks reservoir were done by day labor instead of by contract, it having been felt that the many uncertainties to be anticipated rendered this procedure advisable.

The Gravity Main.—The gravity main from the headworks or Caron reservoir to the city is of 18-inch welded steel with Custer joints of the type already described. The invert is laid at an average depth of 9 feet. To facilitate examination and repairs, it is divided by gate valves into sections averaging one mile and two-thirds in length. The entire pipe is laid on either a rising or a falling gradient, the objects being to permit entrapped air to rise to the summits where air valves are provided. At each air valve there is provided also a poppet inlet valve for the purpose of admitting air whenever a section of the line is drained. Six-inch drains are provided at all depressions and are controlled by six-inch gate valves. These will permit the main to be unwatered in sections when necessary.

Storage Reservoir.—The storage reservoir at Moose Jaw has a capacity of 2,000,000 gallons. It is rectangular in plan and is divided transversely by a partition into two equal parts. The 18-inch gravity supply main from Caron divides at a point exterior to the wall and an inlet branch goes to each half. Each branch is equipped with a Mason, float-operated, balanced valve, which controls the admission of water. Except at such times as the demand of the city services exceeds the capacity of the gravity supply, this arrangement will insure a full reservoir always. The reservoir is of reinforced concrete throughout, the floor having a thickness of 10 inches. The exterior walls consist of panels 18 feet high spanning between counterforts spaced 9 feet on centres. The partition wall is similarly constructed, except that it is designed to resist a full head of water in either direction. The roof is of the girderless type, supported on columns spaced 18 feet both ways, the slab proper having a thickness of 7½ inches. A five-ply felt and gravel covering overlies the concrete roof, and on this, in turn, a filling of two feet of earth is placed.

The Moose Jaw Pumping Station.—The Moose Jaw pumping station is of the same general style of construction as the headworks pumping station. Its equipment consists of two Canadian Böving centrifugal pumps direct connected to two Siemens 35 h.p. motors which receive their power from the supply mains from the city's central power station. These pumps lift the water to the elevated tank, a height of upwards of 110 feet. They will ordinarily draw from the storage reservoir, but the piping arrangements will permit water to be drawn direct from the Caron gravity main. In addition to this, either pump can draw from either side of the reservoir. Finally the piping system will permit of water being fed (without pumping) from the reservoir or from the gravity main into the city's distributing system, either of which would give a moderate pressure over all of the city except the highest parts. If desired, the elevated tank may be cut out and the pumps made to discharge direct into the mains. The motors are equipped with Cutler-Hammer switches operated by a float in the elevated tank. This is intended to keep the tank practically full at all times. The pumping station is supplied with a heating boiler with circuits through the reservoir and the riser of the elevated tank to provide against unusual frost conditions.

The Elevated Tank.—The elevated tank is a steel structure of 75,000 gallons capacity, and is carried on four posts. It is provided with a riser 6 feet in diameter. The bottom is elliptical in section. The tank is provided with a mercury pressure indicating gauge and with floats operating the motor switches in the pumping station. The elevated tank, the Moose Jaw pumping station, and the storage reservoir stand in close proximity on what is practically the highest ground in the vicinity of the city.

As stated previously, the infiltration gallery, the headworks pumping station, the pressure main and the headworks reservoir were all done by day labor. The Wm. Newman Company, Limited, Maurice S. Holmes, and the Moose Jaw Construction Company, Limited, were the contractors for the laying of the gravity pipe line, the pipe itself having been supplied by the National Tube Company through the United States Steel Products Company. The storage reservoir and the Moose Jaw pumping station were constructed by the Moose Jaw Construction Company, Limited. George T. Horton, of Chicago, supplied the elevated tank. Drummond, McCall & Company supplied all valves, fittings and specials. The mechanical equipments at the headworks and Moose Jaw pumping stations were supplied by the Canadian Böving Company, Limited, and the Canadian Fairbanks-Morse Company, Limited.

At the present time the infiltration gallery is laid for only about half its contemplated length, and the system of deep wells across the valley to tap the lower supply has not been constructed. The reason for this is that it was considered best to test out the supply this winter with only part of the gallery in operation. Then, if the conditions require it, the balance of the gallery and the deep wells are to be constructed next season. It is quite likely that the present works will be extended so as to include the whole of the development originally contemplated at the headworks.

The Canadian Pacific Railway, the Canadian Northern Railway and the Grand Trunk Pacific will all be active one way or another on the southern part of Vancouver Island. Following that will be expansion further up the Island, so prospects are good.

There are differences in Vancouver over the Canadian Northern Railway agreement, which will shortly be voted on by the people. At the meeting of the board of trade on Tuesday last, a resolution was carried asking that the people vote against the proposition. It is not probable that the board of trade will be seriously heeded in this matter, for the agreement seems to be supported about the city.

COAL STORED UNDER WATER.*

For some time past the attention of those responsible for the control of large industrial and engineering concerns has been centred upon the problem of effectively storing large quantities of coal so as to avoid, or at any rate minimize the risk of spontaneous ignition, and at the same time prevent undue deterioration in quality. As has been frequently pointed out, coals of the bituminous gas-making type (i.e., coals containing about 30 per cent. of volatile matter) are usually found to be affected to a far greater extent than the less volatile steam coals. The unsatisfactory aspect of the whole question, however, is that there is no definite means by which it is possible to ascertain whether or not a certain coal is one which must be regarded with suspicion. In fact, it frequently happens that a stack of apparently harmless coal will heat up without the slightest warning. Hence the only course open to the cautious engineer is to assume that any and every class of coal is liable to ignition, and to subject each consignment—whatever its tendencies—to similar conditions of storage.

The more common method is merely to dump the coal in large stacks, at the same time observing certain well-established rules and ordinary precautions; but another plan, which, however, is seldom adopted in this country, is to submerge the whole stack in a suitable reservoir of water provided for the purpose. This system is viewed with considerable favor by American engineers, and whenever it has been adopted the additional first cost has been found to be more than balanced by the benefit gained in the form of less deterioration, and, of course, perfect freedom from fire. It was originally suggested by a dock engineer who carried out a number of experiments on pieces of coal which had been accidentally split during transference from ship to shore, and which were subsequently recovered from the river bed. This coal, part of which had probably been submerged for some considerable period, showed on analysis a surprisingly small amount of deterioration, and the same results were obtained when experiments were made with larger amounts. In some cases the dredged coal had been immersed for at least ten years, and even then it was found to have lost little of its original value; while in the case of samples immersed for about three years the deterioration was estimated to amount to less than 3 per cent. This is, of course, a remarkably low figure when compared with that for ordinary bituminous coals stacked in the open in this country, for they invariably show a decrease in value of from 5 to 8 per cent. in the course of 12 months. In more tropical countries, and in climates in which variations and extremes of temperature are abnormal, the loss is naturally very much greater. For instance, coal of the Navy type stored in Hong-kong is said to suffer to the extent of from 20 to 40 per cent. If this is the case with a steam coal, the corresponding amount of deterioration of a bituminous coal would be a somewhat serious consideration.

Advantages of Wet Storage.—If it were possible to maintain an equable and moderately low temperature throughout a coal stack there would probably be little trouble with spontaneous firing, and it is in this respect that the wet method is superior to any other. Nowadays coal stocks kept in hand by industrial concerns are in many cases far too large to be provided with shelter from the weather, and are consequently subjected to varying conditions of snow, rain, frost, and sun. When submerged, however, the material is protected more adequately than if it were housed; and, no matter what are the weather conditions, the variation in temperature of the mass will be comparatively small. It is now generally

*From Scientific Supplement of London Times.

recognized that the gases occluded in the pores of the coal—more particularly oxygen—are indirectly the cause of both heating and deterioration, and their escape should as far as possible be arrested. By immersing coal and keeping it continually sealed this condition is fulfilled, the gases being more or less confined, while little or no oxidation takes place. The breaking up of lumps and pulverization are considerably reduced, because the water forms a cushion between the various pieces, thus lessening the effect of the movement of the lumps one on another, though the better physical condition of the coal is probably due in part to absence of heat, which in itself is to a great extent the cause of the opening out and disintegration of the larger pieces.

Authorities on the question of coal storage are now generally agreed that no air-stacked heap—whether housed or in the open—should be taken to a greater height than about 20 ft., chiefly on account of the danger of the formation of "dust-pockets," which are frequently the primary cause of ignition. There is, however, no limiting depth in the case of an immersed stack, and accordingly a considerable saving of space can be effected. This, again, is a material consideration from the point of view of works lying in the centre of congested districts, where vacant spaces are limited and the price of land excessive. For instance, if 20ft. is to be the maximum height of the stack, the storage capacity is limited to between 40 and 50 tons per 10 sq. yards of ground area, and thus an acre of ground space will accommodate, at the outside, only some 20,000 tons—by no means an excessive quantity in view of the huge demands of industries such as gas-making, in which the larger works carbonize as many as 1,000 to 2,000 tons a day, and in some cases even greater quantities. By adopting the wet storage method the capacity per unit of ground area could certainly be doubled, and there is no reason why it should not be even greater.

Possible Defects.—With all its possibilities and advantages, the storage of coal under water is sure to introduce a certain number of undesirable factors, and perhaps the most serious question to be taken into account is that of expense. At present the cost of stacking coal is considered to be no more than the value of the ground upon which the coal stands, although in addition there should be reckoned the expenses of constant supervision and labor in turning over and working out suspicious parts of the heap. The expense of conveyance to and from the stack may be neglected, because it is necessary in both cases, the extra depth in the wet method being balanced by the saving of distance.

The coal reservoirs—usually constructed of reinforced concrete—must, of course, be designed with foundations varying in accordance with the proposed depth, and in the event of the latter being considerable the expense is somewhat heavily increased owing to the great pressure on the floor and side walls. A further consideration is that of pumping machinery for emptying or filling purposes.

A contingency which must not be overlooked is the possibility of sudden frost and the consequent freezing up of the reservoir to some considerable depth. It is improbable that anything of the kind would occur in this country, and in places where intense cold prevails wet storage would be unnecessary owing to the limited amount of deterioration and greater immunity from fire in such climates.

There is, however, an admirable system in vogue known as the "mixed method," according to which a supply of coal is stored in the open for immediate requirements, and the deficiencies are made good by deliveries. At the same time a certain quantity is stored in the water reservoirs, and this is set aside for use in the case of emergency only. Even should ten years elapse before an emergency arises, the coal (as previously pointed out) should be found to have deteriorated to only a very slight extent.

One of the largest reservoirs constructed for the purpose of storing coal under water is that which it was decided to erect at Stettin about two years ago. The tanks, on the banks of the River Oder, were designed to be capable of dealing with 20,000 tons. Towards the close of 1911 arrangements were also completed for storing 6,000 tons of coal in this way at the works of the Omaha Electric Light and Power Company, and a most elaborate coal-handling plant was erected for working in conjunction with the tanks. In this case the tanks are comparatively shallow, their depth being 22ft., and the side walls are carried on piles owing to a treacherous stratum of quicksand. Piles at a pitch of 5ft. were also driven under the whole of the floor area and capped with square slabs of concrete, upon which the floor rests. In this way the whole of the load is brought upon the piles and none of it is upon the earth. The side walls are about 2ft. thick at the top and 4ft. 6in. at the bottom, and the concrete floor is protected from the bite of the coal "grab" by means of embedded rails.

Effects of Using Wet Coal.—When coal has been subjected to storage under water for any length of time it is usually found to be somewhat brittle and decidedly dull in appearance. But the latter effect is merely superficial, and on drying in the sun it rapidly disappears. In many cases, however, time would not permit of the coal being set aside for drying, and the consumer would be faced with the difficulty of using fuel containing a high percentage of water. For steam-raising and all firing purposes this would no doubt be of little account, but the question cannot be considered lightly when the coal is destined for gas-making purposes. It has long been a general belief—probably an exaggerated one—that if wet coal is carbonized in gas retorts the proportion of impurities will be increased and, in addition, greater quantities of the much-maligned hydrocarbon naphthalene will be evolved. Thus the storing of coal under water would be likely to meet with stout opposition from the gas engineer. However, full charges of coal (that is, charges that completely fill the retorts) are now the order of the day in the gas world, and under such conditions the moisture has practically no evil effect. At any rate, it should be found more profitable to carbonize a wet coal giving a slightly increased yield of impurities than an air-stacked coal which had lost perhaps 10 per cent. of its gas-making value.

SAFETY FIRST.

The Canadian Pacific Railway Company has ordered a sheet filled with mottoes of "safety first" propaganda for distribution. Points already emphasized by numerous safety committees are brought out, as follows:—

I will not stand in front of a moving car, or engine, to board same.

I will always respect the blue flag, because the lives of my fellow-employees depend upon it.

I will not hold on to the side of a car when passing platforms, buildings or obstructions close to the track.

I will not shove cars into a freight shed, or on team tracks, without first making sure that all men and teams are clear.

I will not kick cars into sidings, where boarding cars, or cars being loaded, or unloaded, are standing.

I will remember that it is better to let a train wait than to cause an accident.

I believe that Safety First is simply a habit and I will cultivate the habit.

The prevention of accidents is a duty I owe myself, my family, and my fellow-employees.

I will take out immediately sufficient accident and life insurance to protect myself and those dependent upon me.

MAMMOTH FLOATING DOCK.

Paralleling the increase in size and tonnage of ocean-going ships of was is the tremendous size of floating dry-dock constructed to handle them. Lately in England there was placed at Portsmouth a floating dock capable of handling the heaviest of British battleships. An interesting chat about this monster, written by S. A. Mackenzie, a pupil at Queen's Engineering Works, and printed in the Queen's Engineering Works Magazine, follows. The battleship "Monarch," which is spoken of is one of the largest and latest in the British navy. Completed in 1912, it is of 22,500 tons displacement, 27,000 I.H.P., and speed of 21 knots. It has turbine engines and a main armament of ten 13.5-inch guns.

The floating dock, constructed by Messrs. Cammell, Laird and Company, Limited, at Birkenhead, for the British government, at a cost of over a million sterling, is capable of raising a ship of 32,000 tons. It consists of a series of tanks, the total length of which is 680 feet and the breadth 150 feet. On either side two walls 15 feet wide rise to a height of 46 feet above the pontoon deck. These walls are connected by a swing bridge for use when there is no ship in dock.

Along the bottom of the tanks a line of pipes is run with a branch-piece and valve to each tank. These valves are controlled from the valve-house on deck and are worked by compressed air. The air is admitted through a cock opened by means of an electro-magnet, the current being switched on in the valve-house. A switchboard is provided on each side of the valve-house, the position of the switches corresponding to their respective tanks, while above each switch are indicators showing whether the valve is open or shut, and the level of the water in the tank.

The controller can watch the performance of the dock by means of two spirit levels set at right angles.

Placed between the sides of the walls and just below the upper deck are the compartments containing the machinery for working the dock. At each corner are two boilers, and adjoining each boiler-room two horizontal open engines, with vertical shafts which drive the 16-inch centrifugal pumps that are used for raising the dock. These are placed at the bottom of the dock. A condensing plant and fire-pumps, etc., are installed below each engine-room. Throughout the dock is a complete installation of electric light.

The dynamo-rooms are situated at about the middle of the dock on either side, and each contains two Allen 200-kw. sets, consisting of enclosed vertical engines and shunt wound continuous current dynamos. It was in connection with the erection and running of these that I was fortunate in spending several weeks on board the dock. The switchboards are arranged so that all four machines can be run in parallel for supplying current for the dock itself, and to the ship in the dock; also by means of two-way switches either machine can be connected direct to the ship. The voltage of the main generators being 225 volts, two motor-generators (one in each dynamo-room) are provided, with a range of 85 to 115 volts, for giving current to ships with lower voltages. In each dynamo-room is a motor-driven air-compressor for working the valves, pneumatic tools, etc.

On the starboard side of the dock is a large workshop containing lathes, planing, drilling, and screw-cutting machines, punching and shearing machines, while in the smith's shop is a steam-hammer and a set of rollers. The top deck on either side is provided with four steam-driven capstans and a 5-ton electrically driven crane, travelling the whole length of the deck.

On the port side, cabins and a wardroom for the accommodation of twelve men are provided; also extensive lavatories and wash places for the crews of ships in the dock.

The dock was built in a specially constructed basin having a large temporary dam, and when complete a portion of the dam was cut away, and the tide allowed to flow under the dock. Some little difficulty was experienced in getting the dock out of the basin. A high wind was blowing at the time which, catching the walls of the dock, drove it into one side of the dam, where it remained for nearly half an hour, all efforts of the tugs proving unavailing. Anxiety prevailed lest the tide should go down before the dock could be got clear. At last, with a rending of timber, the dock slowly moved forward, carrying with it about fifteen feet more of the dam. Owing to the very strong current in the Mersey it required ten tugs to convey the dock safely to the bar. Here six of the tugs left us, taking with them the men who had assisted in getting us away. We then continued our journey to Portsmouth, and next morning arrived off Holyhead.

The weather was very rough during the whole of the voyage round, but with the dock covering such a great area we could scarcely feet the motion of the sea at all. It seemed very strange to stand on the bridge and watch the tugs rolling and pitching about, while we felt as though we were on terra firma.

Coming up the English Channel the tugs were pulling at right angles to the dock nearly the whole of the time, the wind creating so much pressure on the walls that we were travelling sideways.

A cross-channel steamer seeing us in this position, and being unable to read our signals, sent a wireless message to the shore that we were in difficulties. A cruiser was sent after us from Portland, but on learning we did not require any assistance she turned back.

On arrival at Spithead, it was too windy for us to go into harbor, so we had to put to sea again, and lie off the Isle of Wight all night. Next morning, however, the wind had dropped considerably, and four dockyard tugs came out and towed us safely into Portsmouth harbor, after being eight days at sea.

During the voyage, many amusements were resorted to to pass away the time. Cricket, running and jumping afforded good exercise, while fishing was greatly indulged in, but, sad to relate, only three small mackerel were caught during the whole time we were at sea.

At Portsmouth the trials were satisfactorily carried out, the dock raising H.M.S. "Monarch."

TRADE DISPUTES SHOW DECREASES BOTH IN NUMBER AND MAGNITUDE.

There was further improvement in industrial conditions in regard to the number of trade disputes during January. At the end of the year 1912, there were seven disputes in existence of such magnitude as to affect industrial conditions. and two of these were settled during January. Five new disputes occurred, a feature of which was the fact that by none of them were more than one hundred employees affected. Disputes in existence in January were twelve in number as compared with thirteen during December. The number of employees affected also showed a decrease, being 2,298 as compared with 3,850 during December. The number of working days lost during January was about 48,000, which represents a decrease of more than 18,000 as compared with the December record. There were seven disputes left unterminated at the end of the month.

REPORT OF THE TWENTY-SEVENTH ANNUAL MEETING OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS

This report of the proceedings of the annual meeting of the Canadian Society of Civil Engineers, held in Montreal January 28th, 29th and 30th, 1913, is continued from the February 6th issue of The Canadian Engineer. In that issue the proceedings of Tuesday, January 28th, appeared.

On Wednesday, January 29th, during the morning, the members inspected the Montreal Steel Works at Longue Pointe.

Afternoon Session,
January 29th, 1913

THE PRESIDENT stated that they were dealing yesterday morning with the reports from the branches. He thought they had better go on with the reports of committees.

REPORTS OF COMMITTEES

Report of Committee on Establishment of Testing Laboratories

THE PRESIDENT said the first report was that on the establishment of Testing Laboratories.

MR. MACKAY, one of the members of the committee, said they had not held any meetings during the past year so far as he was aware, so there was nothing he could add to the printed report. Of course, the changes mentioned in the administration of the Department of Public Works doubtless were responsible to a very large extent for the small amount of progress made.

THE PRESIDENT asked if it was the wish of the meeting that the report be received as a progress report and adopted, and that the committee be continued as it stood?

This was carried.

Report of Committee on Educational Requirements

The next committee was that on educational requirements, of which Mr. Marceau was chairman. As he was not present the next report was taken up.

Report of the Examiners' Board

THE PRESIDENT asked Professor Mackay, as chairman of the Examiners' Board, to discuss the report.

MR. MACKAY said that although the report of the Examiners' Board was short, the Board had done a good deal of work during the time it had been organized, the last ten months. The most difficult task was to draw up a syllabus of the examinations, because they had little guidance to help them in that respect, and they were rather between two difficulties, one to set a standard that would really mean something, and the other to make that standard such that no worthy applicant should be rejected. Whether they had succeeded in accomplishing that task he did not know. They certainly had so far to their own satisfaction, but they realized the work at present was only in the experimental stage. The syllabus of the examination should be drawn up and printed, and also a complete set of examination papers, which might serve as some indication of the standard required in Canada. Also a set of examination papers should be printed on the subjects for which candidates presented themselves at the second examination. Two examinations were held. As there was but little time to prepare for those examinations, only a small number of candidates came up this year, most of whom, he thought, succeeded in passing. The committee had also been called upon to examine a large number of certificates presented by men who, although they were not under the strict regulation exempt from examination, still were able to present certificates of educational acquirements which might reasonably be looked into and accepted. Some of these, of course, were accepted and some rejected, and that involved a considerable amount of work. He was sure all the members of the Board would be very glad to receive any suggestions to guide them in continuing the work. It was to the benefit of the Society that they should do so.

MR. SKAIFE thought this committee was a very important one, and they should make it as prominent as possible. One good reason is that if this Society was recognized as an educational Society they ought to be able to secure exemption from taxes, which amount to over $800 a year. He wrote to the committee about that some time ago. When the Government of Quebec regards the Society as an institution of that kind, the City Council would fall into line. He knew it had been the policy all along to encourage education in the province.

THE PRESIDENT thought the Society ought to be considered as an educational institution. They were doing their best to elevate the standard of the engineering profession.

The resolution for the adoption of the report was then put and carried.

Report of the Quebec Branch

THE PRESIDENT then took up the report of the Quebec branch, which had been passed over a few minutes ago because no one was ready.

The report was then read by the Secretary.

MR. DODWELL moved that the report be received and filed.

Carried.

Report of the Canadian Committee of the International Electro-Technical Commission

THE PRESIDENT said the next report was that of the Committee of the International Electrotechnical Commission, and called on Dr. Herdt.

Dr. Herdt said a few words might be added to this report in order that the members might know exactly what was being done.

The Canadian Committee was appointed by the Council of this Society to join with the committees appointed by practically all the great countries of the world to form an Electrotechnical Commission, whose duty is to standardize electrical symbols and also to go into the matter of the standardization of electrical machinery. These committees appoint delegates to annual meetings which are held in different parts of the world. The last meeting was held at Turin, Italy; the next will be held at Zurich, Switzerland.

The Society had a delegate sent from Canada to the last annual meeting. The recommendations made by the different committees were considered, and some of them amended, others approved. As might be understood, such work is, of course, very slow, a great deal of it having to be done by correspondence, as no recommendation can be carried before it has been submitted to the different committees. Publications have been issued by the commission, which had to be submitted to the different committees for approval.

The largest amount of work had been done in relation to the standardization of symbols. It was very difficult in taking up a text book on electrical matters to understand exactly what the different symbols used exactly meant. The committees have practically settled on uniform symbols to denote the various terms in electrical machinery and electrical engineering.

Several committees have been appointed by the different countries in regard to electrical machinery. This is with a view of standardizing principally the rating of electrical machinery, so that when a machine is rated at a certain kilowatt capacity, or horse power, it will have the same meaning throughout the world. The Society committee has been doing considerable work by meeting either in Ottawa or Montreal, getting members together, and making recommendations.

Dr. Herdt hoped this report would be carried by the meeting, and that the members of the committee would be allowed to continue this work for the succeeding year. In that way they would keep in touch with the subject, which was of great importance to Canada, as this country is becoming a large centre for electrical machinery and provides unlimited scope for electrical engineering. (Applause.)

THE PRESIDENT asked if it was the pleasure of the meeting that this report be received and adopted, and the committee continued?

MR. VAUGHAN asked if it would not be a good scheme to reconsider the matter of appointing committees by the general meeting? Why not have them appointed by the council, subject to any suggestions the general meeting wanted to make? They were continuing committees from year to year, and after action was taken by the general meeting the council was powerless to add to a committee, change it, or reach it in any way.

MR. MONSARRAT thought Mr. Vaughan's remarks were well chosen. For instance, in some committees the members were very far spread and during the year they did nothing. In the meantime the council had no power to make any changes. It seemed to him the council ought to have such power so they could make any necessary changes recommended by the Chairman.

DR. HERDT said it was doubtful whether the Canadian Society of Civil Engineers had any jurisdiction over this work. The International Electrotechnical Commission was appointed in England some years ago, and it was understood at that time that the members of these different committees would be appointed by the technical societies and the manufacturing interests of each country, and that if they did not appoint these committees the government would do so. He was present at the first meeting of this commission in London, England, three years ago. He was a member of the special committee which had to draft out rules and regulations governing that commission, and he had pointed out to the different members present, that in Canada at that time they had only one engineering society, and that the Canadian Society of Civil Engineers was really a parent society embracing all engineers, that is, civil, electrical and mechanical. The Dominion Government the first year naturally stepped in and appointed a committee, and practically up to last year sustained it. It had since been continued with funds obtained from individuals and from the commission. They had to send in each year $200 to the Secretary's office in London, and looked after their own expenses. The Canadian Society of Civil Engineers subscribed last year $100, which was only a small portion of the expense they had had to carry themselves. The Canadian manufacturers had subscribed liberally to this work, and individually they had subscribed.

This committee was a very representative one. It consisted, besides himself, of Mr. Higman, who represented the Dominion Government; Dr. Barnes, who represented McGill University; Mr. L. W. Gill, who represented Queen's; Mr. T. R. Roseburgh, who represented Toronto; Mr. Duff, who represented the West; Mr. Kynoch, who represented the Canadian General Electric Company; Mr. Murphy was the electrical adviser of the Board of Railway Commissioners, and Mr. Lambe, the secretary, was also at the head office in Ottawa. So a number of these gentlemen might not be members of the Society of Civil Engineers, and there was nothing in the constitution of this commission to say that they must be members.

He felt very strongly that unless this Society continued their support, morally and otherwise, to this work the committee would have to look elsewhere for assistance. Personally, he had been for a number of years asked by the American Electrical Engineers to join in the formation in Canada of a branch of the American Institute of Electrical Engineers. He had stood against that, and, as they knew, there was no branch of the American Institute in Montreal at the present time, because he thought the Canadian Society should cover the whole engineering field. (Hear, hear.)

When it was discussed as to who should vote, it was decided that each country should have one vote, and Canada was the only country which has a vote outside of great countries like France, England, Norway and Sweden. Thus they were recognized as practically being autonomous, and their importance in this branch of engineering acknowledged.

Therefore he would ask that at this meeting the Society continue its support to this committee, as the work they were trying to do with the other countries was of very great national importance. (Applause.)

MR. MONSARRAT said what he thought was intended by Mr. Vaughan's remarks, and what he intended, was not that they should not support this particular committee, but that the council might have power to change committees on the Chairman's recommendation, and if the Chairman was satisfied with his committee he would not recommend any changes. This was merely giving the council such power as was necessary, so that instead of carrying a lot of dead wood, action might be taken from time to time to strengthen any committee.

THE PRESIDENT said this was a special committee over which they did not have very much jurisdiction. He did not think there should be any change made in this committee. In fact, they had not power to make any change in it.

MR. MURDOCK moved that that report be accepted and the committee continued. It appeared to him the last speaker's argument was a very strong one for leaving the committee alone.

Duly seconded and carried.

MR. MOUNTAIN replying to Mr. Monsarrat's question, said at the present moment all committees had power to add to their number. If they found there was dead wood on, they need not strike such members off, but there was power to add new members.

THE PRESIDENT said the next committee was that on Specification for Steel Bridges, of which Mr. Monsarrat was Chairman.

Report of Committee on Specification for Steel Bridges

MR. VAUGHAN moved that the report be received and a committee appointed by the council to continue the work.

MR. MOUNTAIN wanted to know from this committee if it was their proposal to make the specification of the Canadian Society of Civil Engineers a standard for steel bridges.

THE PRESIDENT said that was the proposal.

MR. MOUNTAIN asked if this meant that the specification for fixed spans was adopted.

MR. MONSARRAT said yes.

MR. MOUNTAIN said on this committee were the bridge engineers of the Canadian Pacific, the Grand Trunk Pacific and the Grand Trunk Railways, and the Chief Engineer of the Department of Railways and Canals. All those men were working under more or less different specifications, and his enquiry was this: If in signing this as members they have agreed, or will agree, to make the standard of the Canadian Society of Civil Engineers their standard? He would tell them why. The Canadian Northern Bridge Engineer, who was present, Mr. Chapman, was not on this committee. Most of these railroads from time to time have branches that have been, or are, subsidized roads. Under their contract with the government they are obliged to build their bridges to the specification of the Department of Railways and Canals. In course of time those bridges are altered, not likely because they have become decayed or rotted out, but in most cases on account of heavier motive power being used. Then these roads come back with another specification on which to build these bridges. All bridges built by all these roads mentioned have got to come before the Dominion Railway Board in his (Mr. Mountain's) department. To-day he was dealing with a specification gotten up by the Department of Railways and Canals, which the Board accepts; he was dealing with the American Engineers' Maintenance of Way Specification for the Grand Trunk Railway; he was dealing with the Dominion Government specification for the Grand Trunk Pacific; he was dealing with the Canadian Pacific's own specification for the C.P.R.; and the Michigan Central have got another. His idea was this, that if the Canadian Society of Civil Engineers, with these men on that committee, feel that they can see their way to making one standard specification for steel bridges, he was prepared to recommend to his Board the adoption of that standard, and bridges will be passed on that standard, and on that standard only. He might say that Mr. Uniacke, the bridge engineer of the National Transcontinental, is also on that committee. He would like to get the views of those gentleman on that question.

MR. MONSARRAT said that was one of the principal ideas they had in drafting this specification, to try and get some uniformity, and he thought the gentlemen who are on this committee would agree with Mr. Mountain's wishes, that they will adopt that as their standard, with possibly a few changes in some minor paragraphs. It was very hard to get a specification that everybody agrees to exactly all the way through, but the general specification could be adopted, and he had reason to believe that this specification would also be adopted by the Department of Railways and Canals, and so make for uniform practice throughout the country.

MR. SULLIVAN said he could not agree for his company. It would be the most unfortunate thing that ever happened to the railways and the public of Canada that such a policy should be carried out. Write up that specification as a standard and nobody had authority to change it. If the Board of Railway Commissioners make a standard, everybody has to stick to it. It would be the beginning of retrogression. He was chairman of a committee that has done some work, but if this Society was going to vote that that specification be made a standard in any department of the government, and compel people to adhere to it, he would vote against it. This Society's recommendations should be educational in form, that is, recommend this as good practice; but every member, student and engineer in the country should have the right and privilege of varying from that specification to suit particular conditions. He would never believe anything else.

MR. DUGGAN said as a member of that committee, he was very much in accord with Mr. Sullivan. All these bridge engineers are not of one mind necessarily as to what is the best practice. The committee got all their opinions together and brought them as far as possible into unison, and put up what necessarily is a sort of compromise specification as being the average opinion of all the men who are more or less expert in that work. As Mr. Sullivan said, they simply put that forward as representing what they thought was the best practice. He thought the Department of Railways and Canals should adopt this specification, but there was no reason why every railroad should also adopt the same specification.

MR. MOUNTAN said he had not made himself clear. No railroad gets a subsidy unless it builds its bridges in accordance with the standard laid down by the Department of Railways and Canals.

MR. DUGGAN corrected him and said, up to that standard.

MR. MOUNTAIN said whether it was the Canadian Pacific, or the Grand Trunk Pacific, they were building to the Department of Railways and Canals specification. The Grand Trunk Pacific are obliged to under their contract with the government. This is what occurs. A railroad is located and plans are submitted to the Railway Board for approval. The company builds its bridges under the American Engineering Maintenance of Way Association specification. The Chief Engineer in presenting the plans states what they are. He is asked if it is a subsidized road. He says, "Yes." He is asked if he has submitted those to the Department of Railways and Canals. He says "No," because until the plans go through your Board they cannot go to them, you fix the location. They are passed under their own standard, say the Canadian Pacific Railway standard. Then they submit under the subsidy contract plans and specifications for those bridges, and they are obliged to conform to the department's specifications.

Three years ago this Society made a standard for water pipes, sewers, etc. (Mr. Ker, City Engineer of Ottawa, was chairman of the committee), for putting crossings under railway tracks. That standard was adopted by the Railway Board and put in their rules and regulations. Now an order simply goes out that the pipes shall be carried under the railway in accordance with the standard of the Canadian Society of Civil Engineers. It has remained so, and it is lived up to.

THE PRESIDENT said that, of course, the Society cannot in any way control the different railways. The mere fact that the Bridge Engineer of each railway company was on this committee does not commit his railroad.

MR. MONSARRAT said that he did not see why it would be really worse to have this specification than the one the government has at present.

MR. SULLIVAN said the government specification was a general specification; this goes very much into detail.

MR. DUGGAN said he was afraid that Mr. Sullivan did not fully understand this specification. This was mostly on the same lines as the Canadian Pacific specification, the Grand Trunk specification, the American Maintenance of Way specification, and the specification of the Dominion Government. There was some difference in practice in matters of loading. This specification, as drawn up, allowed for choice of loading, etc., just exactly as did the Maintenance of Way and the Grand Trunk specifications, and to a certain extent the C.P.R.'s specification. There were some minor changes, but it was simply a matter of codifying the best existing specifications of the day, and with a view to revision of the government specification, which was a little antiquated. He did not think the government would tread on the toes of any railway if it adopted this specification as the standard of good practice, and left the railways free to make it better if they saw fit; but this ought to be the lowest standard.

MR. SULLIVAN said he was speaking in general terms on general principles. The principle of this Society in adopting a certain specification and urging that it be adopted by the railways and by the government was wrong. He had not read the specification, and possibly it was so general that it might not do any harm, but the principle was wrong.

MR. MONSARRAT said with regard to using wooden ties, or a steel floor, or a ballasted floor, there was nothing in the specification to prevent it.

MR. SULLIVAN said he was simply trying to bring out the point that the attempt to get all railways to adopt one specification and agree to it without change was wrong in principle. He belonged to the Maintenance of Way Engineers' Association, and he presumed that 99 per cent. of the work that was done in the grading and building of railroads was in accordance generally with the Association's specification, but he did not think three per cent. of the railroads had adopted that in its entirety without changes. The principle was right to have a specification that would tend to uniformity, but to make that the only standard was wrong.

MR. KENNEDY said they could not pretend to legislate for the whole country, and the putting out of this specification did not tie up anybody.

THE PRESIDENT said in putting out this specification they could only put it forward as the Canadian Society's specification and they could not in any way make any pretense of saying to the Canadian Pacific, the Grand Trunk, or any other road, that that must be their specification. They could adopt any specification. On the other hand, in regard to the Railway Commission, it seemed to him that they must have something to guide them in dealing with the railways, and the better the specification is the better for the railways; that is, the more perfect it is in its get-up the better it is for the railways. This specification has certainly been gotten up by the best bridge engineers in the country, and it seemed to him, from a Railway Commission standpoint, that it would be better they should adopt it, if it were a satisfactory one, (as it should be under the conditions) than that the Railway Commission should appoint some engineer of their own to draw up a specification. The mere fact that this specification was adopted by the Railway Commission could not make it a standard for the railways, although in a certain sense, if it is the Commission's standard the railways must live up to it, although they may go beyond. Therefore, it seemed to him that Mr. Sullivan was hardly clear in his point. The Railway Commission had an undoubted right to get up a specification if they so desire, and they have the power to enforce it on the railways. His point was this, that if the Railway Commission were going to have a specification, it was better in the interests of all concerned that they have a specification gotten up by this very eminent body of engineers than that they adopt one made by themselves, that they will get better results from this body than from any other body in Canada. They had no power to enforce it on the Railway Commission, but if they wished to adopt it there was no power that can prevent them.

The motion that the report be adopted, and that a committee to carry on the work be appointed by the Council, was put and carried.

Report of the Committee on Conservation.

MR. WHITE did not think any extended remarks were necessary in regard to that.

The matter was brought to the attention of the committee, as would be seen in the initial paragraph, by a letter from Mr. Sauder, dealing with the question of the organization and provision of the necessary staff to gauge streams in Canada. The preliminary portion of the report was somewhat of an academic nature, and then followed a brief statement of what had already been done in the various provinces of Canada.

In Nova Scotia some work had been done by the Commission of Conservation. In New Brunswick the Commission had also done some work, and also the St. John River Commission. In Quebec they had gauges at some of the canals, and gauging had also been done by private concerns. In Ontario they had the Hydro-Electric Commission and also the Department of the Interior, the International Joint Commission, and the Department of Public Works. In the Northwest all the work had been done by two branches, the Department of the Interior supplemented by the Department of Public Works. In British Columbia the work was being done by the Conservation Commission.

He had just run briefly over the work that was being done in the various provinces to show the diverse organizations that were engaged upon this work, and anyone who appreciated the value of this work could see at a glance that it was far better that this work should be concentrated in some shape or form. The committee made a few recommendations, which would be found at the end.

The recommendations in brief were that it would be advisable that this work be concentrated in some shape or form, and that preferably some Dominion organization should undertake the work. But the committee did not make that a recommendation concerning action by the Society. He understood from Mr. Mitchell, who was also a member of the committee, that he had a motion to make in connection with that.

MR. MITCHELL said what he had to propose was not with reference to the continuation of the work of the committee. He thought that should proceed. He thought it was the desire of all the members that the committee's work should continue, because they were charged with the state question of conservation. What the burden of this report had reference to was stream measurement. As they all knew, that was one of the most important features they had to deal with in Canada at the present time, particularly in reference to the development of the country, and as was very evident from the report, and as had been pointed out by Mr. White, there was great confusion in the methods of investigation of stream measure throughout Canada. There were many bodies which were carrying on those investigations, and there was comparatively little uniformity in doing the work, while the results were put in various forms and kept in various places.

He had a proposal to make which was entirely separate from the question of the continuation of this committee, and it was that the question of stream measurement be taken up by the Council of the Society directly as representing this Society, and that an effort be made to interest the various Government Departments of the Dominion and the Provinces, looking towards co-ordination of these various investigations. He thought it was the place of the Council of the Society to initiate this, rather than that of a Committee of the Society. The Council was a more stable element, and was perhaps in many ways better able to carry on this work than a Committee which was spread from coast to coast and of such a character that the work would fall on two or three members of the Committee. Consequently he presented this motion:—

Whereas this Society is of the opinion that it would be to the general advantage of Canada if a comprehensive system of hydrographic surveys was organized and prosecuted by some central body, with special reference to stream measurement;

Be it resolved that the Council of this Society be directed to initiate with the proper officers of the Dominion Government and the various Provincial Governments a proposal looking to the co-ordination of all stream measurement investigations which are now being carried on by the several Dominion and Provincial Government departments in various regions of the country, with the ultimate object of consolidating and continuing such investigations under some central body.

It was the desire not to specify how this could be done, or what that central body might be, but he thought it would be much to the credit of this Society, and it would be a very fruitful piece of work to the country, if this Society could initiate some movement which would co-ordinate this work into some commission or some department of the government. It was not for the Society to say, but it was for the Council to say if some such arrangement could not be made.

MR. WHITE said, in reference to Mr. Mitchell's remarks, he wanted to make clear what he intended to say at the outset. The Commission of Conservation had done some work in this connection, but it was done very much against his will, and the commission will not do any work of this character which it can induce any other organization to undertake. It must be taken up in practice by some Department of the Government; that was a matter of course. The Commission of Conservation could not undertake this work. He took this opportunity to emphasize this, otherwise some-one present might think that because of his connection with the Commission he wanted this resolution passed.

MR. McCOLL seconded Mr. Mitchell's motion.

The motion was then put and carried.

The other motion, that this report be adopted and the committee continued, was adopted unanimously.

MR. MITCHELL moved that two additional names be added to the committee, namely, Mr. J. B. Challies, superintendent of water powers in the Department of the Interior, and Mr. P. M. Sauder, the chief hydrographer of the Irrigation Branch of the same Department.

Seconded.

MR. OLIVER moved an amendment to the motion that these names be sent on to the committee, with a recommendation that they be added to the committee.

MR. MITCHELL, with the assent of his seconder, withdrew his motion in favor of the amendment proposed by Mr. Oliver.

THE PRESIDENT said that this motion was now in the form of a suggestion to the committee that they add those two names to the membership.

Carried.

Then the motion that this report be received and adopted and the committee continued was carried.

THE PRESIDENT then said that in addition to these reports a number of the committees had not reported at all. Two committees did report, but not in time, namely, the Roadbed and Ballasting and the Good Roads Committees. These are specifications rather, and they have not been sent to the members, so that they are not in a position for this meeting to act upon them.

There were also no reports from the Committees on Railway Ties, Transportation Routes, Rail Fastenings and Tie Plates, Cement Specifications and Sewage Disposal.

He confessed to considerable surprise and disappointment that there was no report from one of these committees especially, and that is the one on Cement Specification. He asked the pleasure of the meeting in regard to the committees which had not reported.

A MEMBER moved that the Council be empowered to re-appoint them, or appoint other committees in their place.

Seconded and carried.

NEW BUSINESS

THE PRESIDENT here said in connection with new business he would like to get the proposals of British Columbia before the meeting. It was getting late, but the matter was important. He would be glad to hear from the representatives of the Vancouver Branch.

MR. ROBINSON said there were very many matters which frequently came up before the engineers of British Columbia that could best be taken care of if the large number of engineers residing in British Columbia and members of this Society could in some manner co-operate, to the end that their interests will be taken care of. It had frequently happened that the Society, as a Society, had had to appeal to the Provincial Government on matters which should properly come from the Canadian Society of Civil Engineers at the Montreal headquarters. But, unfortunately, matters moved so quickly in the West that they had not time to institute the proper proceedings and appeal to headquarters here and get action from the Council and return answers to the British Columbia engineers until matters have gone so far as to make it impossible to apply any remedy.

They would like to have this Society give the engineers of British Columbia authority to assemble and transact such business as requires immediate action; but let them have a set of by-laws framed up and thoroughly approved by the Council. Make those by-laws uniform if they wished. They did not desire to separate from the Society of Canadian Engineers, nothing of the kind, and they did not wish even to take any powers of government from the main Society, but they would like to have the main Society make it possible for them to be a unit recognizable by the Provincial Government. Let them realize that this Society is established in British Columbia. That was the point.

He had not framed the exact wording of a resolution to carry this into effect, but he thought he could safely leave it in their hands for some impartial person to frame a resolution which will permit the British Columbia engineers to get together in a unit for the protection and the advancement of the profession which they represented.

After a long discussion on the question, the meeting was adjourned, the matter to be further discussed the following day.

(To be continued next week.)

ONTARIO LAND SURVEYORS.

The Ontario Land Surveyors held their twenty-first annual meeting on the 25th, 26th and 27th of February, at the Engineers' Club, King Street West, Toronto. Their banquet, Wednesday evening, was a great success and most enjoyable. Several friends and representatives of sister societies of the association were present to enjoy their hospitality and programme. Among these was the Honorable Mr. Hearst, Minister of Lands, who attended and gave a very fine speech. The programme was as follows, and some of the papers presented will be published in The Canadian Engineer shortly.

TUESDAY, 25th FEBRUARY.

Morning, 10 O'clock.—Meeting of Council of Management; meeting of standing and special committees.

Afternoon, 2 O'clock.—Reading of minutes of previous meeting; correspondence; president's address, T. B. Speight; report of council of management; report of the secretary-treasurer; report of the board of examiners; report of committee on legislation, G. B. Kirkpatrick, chairman; report of committee on publication, A. J. VanNostrand, chairman; report of committee on topographical survey, Thos. Fawcett, chairman; report of committee on exploration, J. F. Whitson, chairman; paper, "Colonization in Northern Ontario," H. M. Anderson; paper, "Aliquot Parts of Township Lots," J. S. Dobie; paper, "Gold Mining in Yukon," E. D. Bolton; paper, "International Boundary Survey East of the St. Lawrence River," Thos. Fawcett.

Evening, 8 O'clock.—Lecture on Panama Canal, A. J. Grant, superintending engineer, Trent Valley Canal, Peterborough; paper, "Modern Engineering Improvements," J. G. Sing, district engineer, Ontario Division Dominion Public Works.

WEDNESDAY, 26th FEBRUARY.

Morning, 10 O'clock.—Report of committee on land surveying, C. J. Murphy, chairman; report of committee on polar research, Willis Chipman, chairman; paper, "Methods of Subdivision of Nine Mile Townships in Ontario," H. J. Beatty; paper, "Subdivision Surveys in Alberta," C. E. Bush; paper, "Boundary Line Between Augusta and Edwardsburg Townships," Willis Chipman; paper, "Notes on Survey Act," C. H. Fullerton; paper, "Diagonal Street Surveys in Great Britain and Canada," T. D. LeMay.

Afternoon, 2 O'clock.—Report of committee on engineering, Owen McKay, chairman; report of committee on Drainage, George Ross, chairman; paper, "Forestry in Ontario," E. J. Zavitz, superintendent of Forestry in Ontario; paper, "Concrete Roads," W. A. McLean, chief engineer, Good Roads Department; paper, "Notes on Wawaitan Power Plant," Robert Laird; report of auditors, J. W. Fitzgerald and R. R. Grant.

Evening, 7.30 O'clock.—Dinner at McConkey's restaurant.

THURSDAY, 27th FEBRUARY.

Morning, 10 O'clock.—Report of committee on repository and biography, L. V. Rorke, chairman; report of committee on entertainment, A. T. Ward, chairman.

W. F. STANLEY & COMPANY, LIMITED.

Owing to the continued expansion of business, the W. F. Stanley & Company, Limited, 4 and 5 Great Turnstile, London, W.C., have been compelled to provide for larger office accommodation and will henceforth occupy the premises at 286 High Holborn, retaining their old quarters for export only. All communications to this firm in future should be sent to their new address.

GOOD ROADS EXHIBIT.

The First Good Roads and Construction Exhibition in Canada proved to be more successful than was generally expected. Held in the Dairy Building, Toronto Exhibition Grounds, on Wednesday, Thursday and Friday, 26th, 27th and 28th of February, the Ontario Good Roads Association Exhibit was advantageous to both members in attendance and to exhibitors. The registered attendance at the convention was over three hundred and represented the different cities, towns and counties of Ontario. Some of the papers presented will be published shortly. The following is a list of the exhibitors with names of some of the representatives who were present:

Abram Cement Tool Co., of Windsor, Ont., was represented by Mr. J. D. Abram, who is the inventor of the Abram automatic cement sidewalk tools. The claim made in connection with these tools (finishing trowel, jointer and edger), is that every 20 hours steady use of a full set will save in labor the cost of the tools. The use of these tools was well demonstrated, and they certainly have enough good points to warrant their trial by every contractor who lays cement sidewalks.

Buffalo Pitts Co., of Buffalo, N.Y. This company imported for the occasion a double-cylinder, steel-geared contractor's road locomotive, with several reversible stone spreading cars, which were demonstrated on the roads outside of the building. Also occupied space in the building. This organization presented a good exhibit. The representatives present were Messrs. F. T. Batchellor, B. F. Hoffman and Jas. T. Mack.

Hugh Cameron & Co.—They represented the Waterous Engine Works Co., of Brantford, and exhibited on the road outside the building a Waterous double-cylinder road roller. The exhibit was in charge of Mr. Hugh Cameron. A Buffalo Pitts scarifier was exhibited in their booth.

Canada Cement Co. was well represented by members of the Ontario and Quebec staffs. They exhibited several models of concrete roads. By means, also, of a small lantern, excellent views of roads, bridges, etc., made of concrete were shown. The representatives present were Messrs. Lapierre, Twoey, Dunlop, Cole, Robertson and Wright.

The Canadian Engineer.—This journal had a booth and was ably represented by Mr. P. G. Cherry, circulation manager. Modesty forbids us to mention all our good points. The great thing was, we were there, ready to help, if possible, and still more ready to dispense information of general interest through the columns of our journal for others. Always we are ready to do this, and we trust our readers will bear it in mind.

Corrugated Pipe Co., of Stratford, Ont., represented by Mr. S. R. McConkey, showed samples of tneir corrugated iron culverts.

Ontario Bridge Co., of Toronto, erectors of bridges, concrete and steel; also showed some photographs of some of the construction work they have undertaken, and exhibited a special type of road dray. Mr. Edgar Price was in charge.

Ontario Government exhibited six models showing the development of the modern type of road construction. The Roman, French, waterbound, macadam and other types were instructively portrayed. Mr. Gray, assistant to the Chief Engineer of Highways of Ontario, had charge of the exhibit.

Ontario Rock Co., of Toronto, exhibited samples of trap rock. The company was represented by the general sales agent, Mr. W. A. Stewart.

Paterson Manufacturing Co., manufacturers of Tarvia Pavements, was represented by Messrs. Smith and Barnett. The claims for "Tarvia" are that it will, in one of its forms or another, solve every Macadam road problem, provide a dustless, cheaply maintained surface, and reduce general road costs. The booth was in a prominent corner and had many visitors.

Rocmac (Ontario) Limited, exhibit was in charge of Messrs. Allen and Seers. Photographs of roads constructed of Rocmac were shown. Many enquiries were received from interested members attending the convention.

Sawyer-Massey Co., of Hamilton, Ont., exhibited their machinery both inside and outside of the building. At the inside exhibit there was shown a stone crusher; outside was demonstrated a Sawyer-Massey steam road roller. This company also manufactures gas tractors, as well as a full line of road-building machinery. Mr. E. Crawford, manager of the good roads machine department, was the representative in charge.

United States Steel Products Co. showed samples of Triangle Mesh concrete reinforcement. The exhibit was in general charge of Messrs. Fred and C. H. Brurcke, the Toronto managers.

Wettlaufer Bros., of Toronto, showed a Wettlaufer traction mixer, with heart-shaped drum, a Mitchell stone crusher and other machinery such as concrete brick-making machinery, etc. This interesting exhibit was in charge of the Wettlaufer brothers and attracted a great deal of attention.

Other companies than those exhibiting were represented at the show. Among them were:

The Barber Asphalt Paving Co., of Philadelphia, represented by Mr. Gordon Smith, of Montreal, and Mr. P. S. Coyne, of Buffalo.

Lecky and Collis, of Napanee, Ont., manufacturers of Napanee rock drills and hoisting engines, and sales agents for Austin cube mixers and trench excavators, Priestman buckets, etc. Mr. Collis represented the company at the show.

The Thew Automatic Shovel Co., of Lorain, Ohio, represented by Mr. H. A. McLaughlin.

The Asphalt and Supply Co., of Montreal, represented by Mr. O. G. Carscallen, the Toronto manager.

The Hagersville Crushed Stone Co., represented by Mr. Robert Hambleton, of Hagersville, the president of the company.

The M. Rumely Co. Inc. of La Porte, Ind., manufacturers of steam and oil tractors and grader attachments.

COAST TO COAST.

Ottawa, Ont.—The revenue of customs receipts for the eleven months ending February 28 was $103,485,000, compared with $17,716,000 for the corresponding eleven months of the last fiscal year. This shows an increase of $25,-769,000 or, in other words, the increase for the eleven months of this fiscal year is greater than the entire customs revenue for the fiscal year 1898-99, which was $25,734,000. The revenue for the month of February was $9,155,000, and for the corresponding month last year $7,447,000, being an increase of $1,707,000.

Port Nelson, B.C.—The cost of surveys of the 420 miles of new road from Le Pas to Port Nelson, which have been made, amounts to $156,430. The construction up to date on McArthur Bros.' contarct has cost $354,830. Supplies, including rails, etc., have cost $195,343, while the bridge over the Saskatchewan at Le Pas was erected at a cost of $108,000.

Ottawa, Ont.—At a recent session of the Senate Senator Chaquette asked for papers relating to the proposed Quebec drydock, which has been under consideration for the past fifteen years without anything definite being done. Senator Power said as there was a great dock in Montreal there did not seem to be justification for the expenditure of a large amount of government money to build another dock so near as the city of Quebec. There would not be enough work for the two docks, and the expense of maintenance would be thrown on the government.

Ottawa, Ont.—The board of control of this city are applying to the Federal Government and also to the governments of Ontario and Quebec to secure the necessary legislation to permit the city to get a supply of water from the lakes of the Gateneau hills. This is the recommendation of the British experts, who estimated the cost to be $7,000,000.

Montreal, P.Q.—The firm of B. J. Coghlin Company, Limited, advise that they are leaving their present offices on St. Paul Street, corner of St. Francois Xavier, on or about the 1st of March, to occupy the new buildings erected next to their factory on Ontario Street East, Montreal. For almost fifty years their name has been associated with St. Paul Street, and while loath to leave a locality where they are well known, increase of business necessitates it.

PERSONAL.

WILLIAM N. ASHPLANT has been appointed city engineer of London, Ont.

MR. W. H. BEMAN, of Montreal, has been appointed commissioner in charge of the street paving for the city of Sherbrooke, Que.

JAMES IRVINE, resident engineer of the Canadian Pacific Railway at Kingston, has been moved to Toronto. L. S. Rudder, of Toronto, will take his place.

MR. PERCIVAL LANCASTER has been appointed city engineer of Belleville, Ont., in succession to James G. Lindsay. Mr. Lancaster commences his duties at once.

JAMES HUTCHEON, ex-city engineer of Guelph, Ont., has accepted a position in the Department of Lands, Forests and Mines at Toronto. He will remain a resident of Guelph for the present year at least.

M. H. BAKER, city engineer of St. Thomas, Ont., has been appointed city engineer of Prince Albert, Sask. It is understood that Mr. Baker will commence his duties in Prince Albert almost immediately.

ALAN FRASER, B.A.Sc., has been appointed engineer to the Toronto Iron Works, Toronto. He leaves the office of the district engineer of the Canadian Northern Railway this week to enter into his new duties.

MR. C. H. CUNNINGHAM has just entered into his new position with the Thor Iron Works of Toronto, of which company he is a director. Mr. Cunningham has been associated with Frank Barber, civil engineer, of Toronto, for the past two years.

HUGH GALL, B.A.Sc., has been appointed assistant engineer to Frank Barber, consulting engineer and engineer to the county of York. Mr. Gall will be remembered as having led the Rugby team of the University of Toronto in several of its inter-collegiate and national victories of the last few years.

FRANCIS H. PARR, of the Institution of Municipal and County Engineers, and the Royal Sanitary Institute, has been appointed as permanent engineer for the municipality of Kildonan. He has had ten years engineering experience in different public works carried on during that time in the suburbs of London. There were about forty applications for the position.

THOS. C. KEEFER, C.M.G., LL.D., of Ottawa, past president of the Canadian Society of Civil Engineers, and also the American Society of Civil Engineers, has been elected honorary member of the Institution of Civil Engineers. Some idea of the extent of the honor conferred may be gained by the fact that there were only twenty honorary members in in 1912, including H.I.M. the Emperor of Germany, H.R.H. the Duke of Connaught, Prince Auguste D'Arenberg, Lord Alverstone, Earl Brassey, Rt. Hon. Joseph Chamberlain, Earl of Cromar, Earl Curzon, Viscount Kitchener, Duke of Northumberland and Lord Strathcona.

COMING MEETINGS.

THE CLAY PRODUCTS EXPOSITION.—To be held in the Coliseum, Chicago, Feb. 26th to Mar. 8th.

AMERICAN INSTITUTE OF CONSULTING ENGINEERS.—A meeting for the purpose of further discussing "Professional Relations," will be held at the Engineers' Club, 32 West 40th St., New York City. Tuesday evening, 8 p.m., March 11, 1913. Secretary, Eugene W. Stern, 103 Park Ave., New York City.

THE CLEVELAND ENGINEERING SOCIETY.—Regular meeting, Chamber of Commerce Bldg., March 11th, 1913. Illustrated Paper on "Storage Batteries," by H. H. Smith, Chief of Research Dept., Edison Storage Battery Co., Orange, N. J. Secretary, David Gaehr.

ILLINOIS WATER SUPPLY ASSOCIATION.—The Fifth Annual Meeting of the Association will be held at the University of Illinois, Campaign-Urbana, Ill., March 11th and 12th, 1913. Secretary, Edward Bartow.

CANADIAN MINING INSTITUTE.—Annual Meeting will be held at Chateau Laurier, Ottawa, March 5th, 6th and 7th. H. Mortimer Lamb, Windsor Hotel, Montreal, Secretary.

CANADIAN ELECTRICAL ASSOCIATION.—Annual Convention will be held in Fort William, June 23, 24 and 25. Secretary, T. S. Young, 220 King Street W., Toronto.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, Phelps Johnson; Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

MANITOBA BRANCH.—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack, 83 Canada Life Building, Winnipeg. Regular meetings on first Thursday of every month from November to April.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, A. R. Décary; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, E. A. James; Secretary-Treasurer, A. Garrow. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, G. E. G. Conway; Secretary-Treasurer, F. Pardo Wilson, Address: 422 Pacific Building, Vancouver, B.C.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer. J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. W. Lines, Edmonton; Hon. Secretary, W. D. Cromarty, Edmonton, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Hon. W. A. Charlton, M.P., Toronto; Secretary, James Lawler, Canadian Building, Ottawa.

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