Please read and send in as full discussion as possible at earliest date

The Canadian Society of Civil Engineers

INCORPORATED 1887.

ADVANCE PROOF—(Subject to revision)

N.B.—This Society, as a body, does not hold itself responsible for the statements and opinions advanced in any of its publications.

THE CURRENT METER RATING STATION AT THE IRRIGATION OFFICE, DEPARTMENT OF THE INTERIOR, ALBERTA.

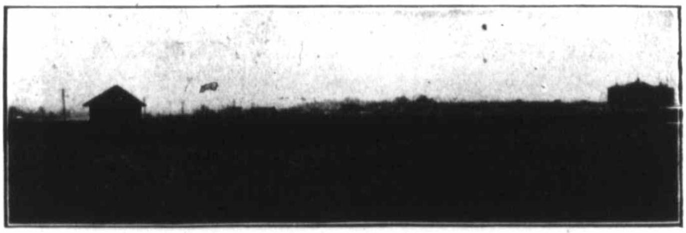
By F. H. Peters, A. M. Can. Soc. C.E.

TO BE READ AT THE MONTHLY MEETING OF THE SOCIETY, OCTOBER [illegible]TH, 1912.

The work of stream measurements has been carried on by the Irrigation Office, Department of the Interior, for a long period of years in the two provinces of Alberta and Saskatchewan, but it was not until the early part of 1909, that the great importance of this work was recognized by the Department and at that time a special Hydrographic Surveys branch was organized under Mr. P. M. Sauder, C.E., from which time the work of stream measurements has been carried on systematically and extensively.

Prior to this time a current meter rating station had been established on a slack water mill pond on Bow River at Calgary, but its equipment was never very satisfactory, and it finally fell into bad repair and its use was discontinued. Along with the formation of the Hydrographic Surveys branch was considered the matter of establishing an up-to-date and efficient current meter rating station because it was realized that without this equipment, by which means all current meters used could be frequently rated, the current meter records would be liable to serious errors.

No active steps were, however, taken in the matter until the winter of 1910, when the plans, specifications and estimate of cost for the station and equipment were prepared by the writer. The contract for the work was let to the firm of Jones, Blackshire and Lyttle of Calgary, on May 29th, 1911, and was completed by them on July 21st, 1911. In carrying out the construction the steel reinforcing, the steel rails, the cement, and the car were supplied by the Department and the City of



A panoramic view of the current meter rating station.

View showing car house and platform at end of tank from which to attach meter to car.

Calgary laid the water supply pipe to the edge of the rating station property. Everything else was included in the contract except some small electrical fittings which were installed after the work was completed under the writer's supervision. The total cost of the station and equipment was $4,475.39. The total estimated cost for the station was $4,690.24.

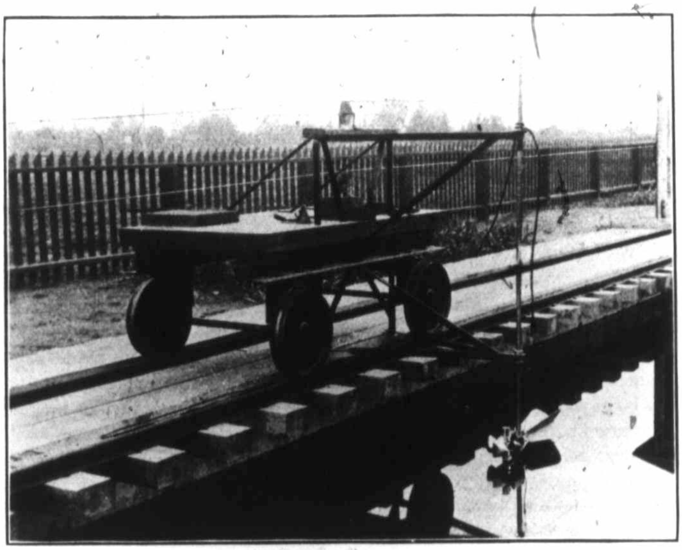
In designing the work the aim was to gain the most perfect apparatus possible for rating the current meters and to create a permanent structure so that it was early decided to use concrete in the construction of the necessary tank.

As no stretch of still water having a suitable length and depth was available, it was necessary to create a tank, and in studying its design two points had to be principally considered. First, as the water supply had to be taken from the city mains the tank had to be made proof against any leakage, as the city authorities were not willing to guarantee any large supply of water such as might be required if any serious leakage from cracks developed in the tank. Secondly, the cross-sectional water area was required as small as possible and yet of sufficient dimensions to guard against any following on movement of the water, in running the meters through the tank. To overcome the first difficulty a heavily reinforced structure was designed, such that being emptied and exposed to the weather in winter no temperature cracks could develop and the inside faces of the tank were water-proofed by Sylvester's process. In deciding on the proper cross-section of the tank to overcome the second difficulty no data were obtainable, but with the tank as constructed no following on movement or undue disturbance of the water has been observed, even with the largest meters tested at velocities as high as 10 feet per second. The length of the tank (250 feet) was adopted in order to bring the cost of the structure within the limits of the amount of money available, but provision has been made in locating the tank for its future extension to a length of 500 feet, which is desirable in order to attain the highest degree of accuracy.

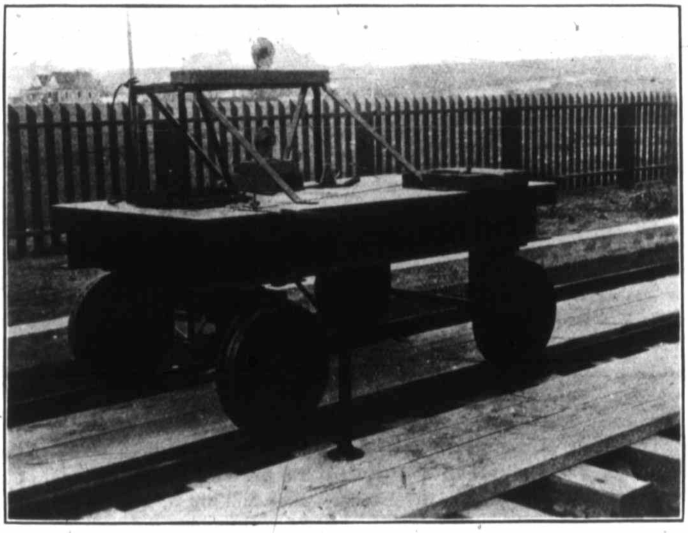
A description of the station will be given, the various points of which will be made clear by referring to the several plates.

The main feature of the station is a car to which the current meter is attached and carried through the water in the tank at different uniform rates of speed. The three elements, the distance, the time, and the number of revolutions of the meter, are mechanically measured and from these, the velocity of travel of the current meter through the water is related to the revolution per second of the meter, which relation of revolutions to velocity constitutes the rating of the meter.

The concrete tank is 250 feet long with an inside width and depth of 6 feet by 5 feet 6 inches, and the depth of water to be maintained is 5 feet. The floor and walls are 8 inches thick and are reinforced heavily, longitudinally and transversely, with ½ inch round mild steel rods, in order to absolutely preclude any temperature cracks in the concrete.



View showing meter suspension irons.

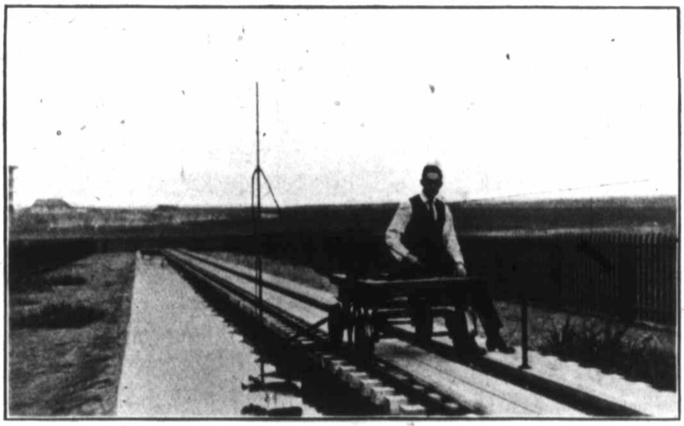


View showing electric switches and trolleys on car.

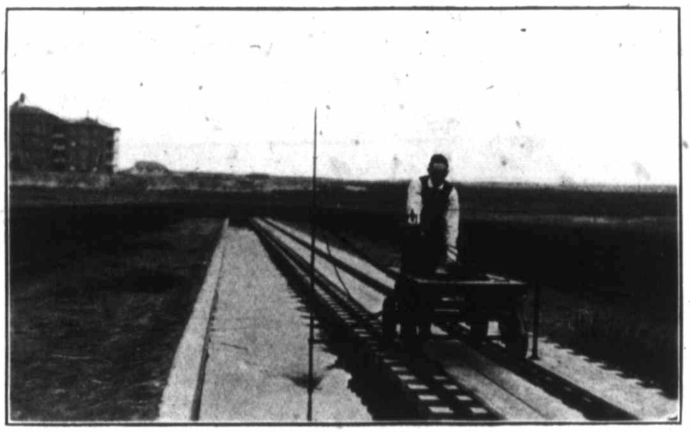
The concrete was specified a mixture of 1 part portland cement to 7 parts clean river gravel to have at least 15 turns in a good machine, and to be placed wet and thoroughly tamped. All the interior faces were thoroughly spaded in order to create a smooth close grained surface, to which to apply the Sylvester's wash. All steel rods at joints were overlapped 16 inches and it was specified that they were to be wired so as to have contact throughout the whole of this length. The tank floor was laid on an 8 inch foundation of large stones overlaid with smaller stones and gravel, in order to provide thorough drainage for any water which might leak through the tank, so that when the tank is emptied in winter and exposed to the weather no heaving might result from any water being lodged under the tank bottom. The soil beneath is of sandy character, which is permeable to water. The water supply is from a 2 inch iron pipe laid from the city mains and a 6 inch tile drain 224 feet long, fitted with an iron gate valve at the tank, allows the tank to be emptied at any time into the Bow river. After the tank was completed all the inside faces were treated with two coats of Sylvester's wash. At the time of writing, the tank has been exposed empty to two cold snaps with the thermometer at —30° and no cracking of the concrete whatsoever has resulted, except a few hair line cracks near the top of the walls. As regards the water-proofing, two observation shafts were left along the tank sides running down to the foundation and no leakage whatever was observed during the summer when the tank was full except a slight dampness at the bottom of the side walls. It should be noted that another reason why it was desired to make the tank leak-proof is that it is intended to obtain evaporation records at the tank in future seasons.

The track laid along the side of the tank for the car is of 16 pound rails and laid to a gauge of 32 3-8 inches on 4 x 6 inch ties, fish plates and bolts being used at every joint. In laying the track, the greatest care was exercised to get it laid solid and as level as possible with close rail joints in order that the car would run on the track as smoothly as possible. The measured run of the car is 200 feet, 25 feet being left at each end of the track in which to speed up the car, and the track at one end runs into the car house where the car is kept under lock and key, when not in use.

The original idea was that the car should be mechanically driven by an electric motor working on one of the axles of the car. It is an essential that the rate of travel of the car over its measured course should be uniform, but after much consideration the writer was not able to devise any method of control by which the rate of travel of the car could be kept uniform (without acceleration) throughout its run, if driven by an electric motor or some other mechanical means. The car is therefore propelled by hand, but its design is such that an electric motor can be easily attached at any future date if any means can be devised of overcoming the difficulty mentioned above.



Meter rating car at rest; note the switch operating rod upright at right and the "time" push switch opposite, near the left wheel.



Meter rating car in motion.

The main features in the design of the car have been copied from the car used by the Bureau of Standards, United States Government, at their current meter rating station at Washington, D.C., blue prints of the design of which were very kindly lent by an officer of the Bureau of Standards.

The main features of the car are that the axles run in roller bearings and the platform is attached to the front axle by a pinion joint which makes the level of the platform entirely dependent on the rear axle, and thus any tendency of the platform to be twisted due to uneven tracks is overcome. It is thought that this arrangement eliminates practically all the sharp vertical movements which might otherwise be transmitted to the current meter in its travel through the water. Two horizontal iron arms project from the car to the centre of the concrete tank. When rating the meter with the rod suspension the meter rods are clamped in these horizontal arms. When rating the meter with a cord suspension and weights the vertical cord is run down through the sockets used for clamping the meter rods, and a removable iron arm is used for attaching a wire stay line to the meter. The car wheels have solid flanges and all the iron in the car is of heavy section, the idea being that with a heavy car running in easy bearings it would be easier to maintain a uniform rate of travel than with a light car.

In making the run with the meter the count of the revolutions of the meter, and of the time interval, are both automatically registered in the car house by electric apparatus. The electric circuits from the car into the car house are made by two trolley wires above the car and one wire laid along the ties between the tracks. The circuit from the meter for the count of the revolutions is made by the two trolley wires, while the circuit for the time interval is made by the ground wire with one auxiliary wire, and one of the trolley wires used for the return. The diagram submitted will show the layout of the electric

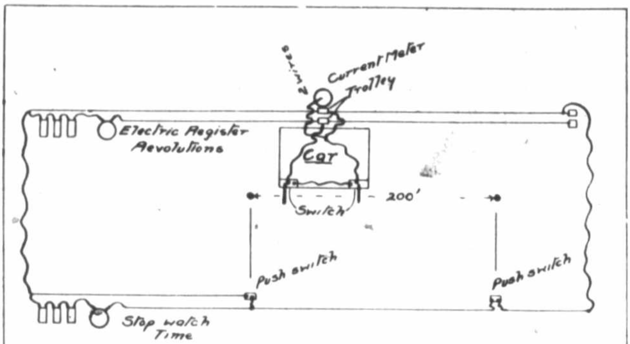
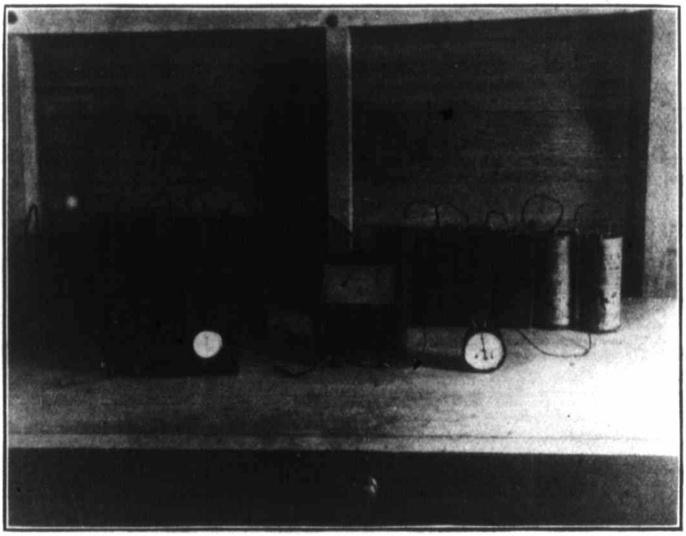


Diagram of Electric Connections

circuits clearly. The distance over which each run is made is 200 feet and this distance is marked by two rods set up vertically on the ties at the side of the car. On the car platform are two electric switches with long arms projecting over the edge of the car platform, and these, engaging with the two rods at 200 feet interval, close the electric circuit for this interval, running through the commutator box on the meter and thus the revolutions of the meter over the interval of 200 feet are transmitted to the car house where they are registered by two electric registers set in series in order to check each other on the count. Some difficulty was experienced at first in getting the electric registers to count accurately when running the meters at high velocities, but this difficulty was overcome by always over-hauling the commutator box on the meters and making a fine adjustment of the make and break apparatus therein. It will be seen that this method of counting the revolutions is liable to be slightly in error owing to the fact that the registers do not take any count of the fractional revolution of the meter at either end of the run. This error, however, would be reduced to a minimum by increasing the length of the run.

The time interval is counted by a stop watch, which is operated by a simple electro magnet, with a padded lever attachment, designed by



Electric recording apparatus, stop watch for time interval and two registers in series for meter revolutions count.

the writer, in exactly the same manner that a stop watch is operated by hand. At each rod, marking the 200 foot interval, the circuit running through the stop watch via the two ground wires has inset a one nipple push switch, and lugs, underneath the car, make and break the circuit as the car passes these two points, thus starting and stopping the watch at the respective ends of the 200 foot run and thereby counting the time taken by the car in making the run of 200 feet.

The procedure adopted in rating the meter is to make 20 runs for each meter with velocities varying from 0.5 feet per second to 10 feet per second, the increments in velocity for each run from the low speed to the high being as uniformly distributed between the limits as possible. From the data thus gained the revolutions per second with their corresponding velocities per second are computed, the points plotted and among them the most probable curve is drawn. From the rating curve thus constructed the rating table is prepared for use in the field and office, showing in convenient tabular form the velocities corresponding to the various revolutions per second of the meter, from zero velocity up to 10 feet per second. It should here be noted that the rule in the service is not to measure any stream at a section where the average velocity falls below 0.5 feet per second, and a velocity of 10 feet per second is about the highest met with in practice.

Mathematically, the most probable curve is that drawn from values found from normal equations by the method of least squares. It is considered, however, that the method adopted of taking the values off a curve carefully plotted as noted above is quite accurate enough to meet all practical requirements, and the saving of time and labour by using this method is very great.

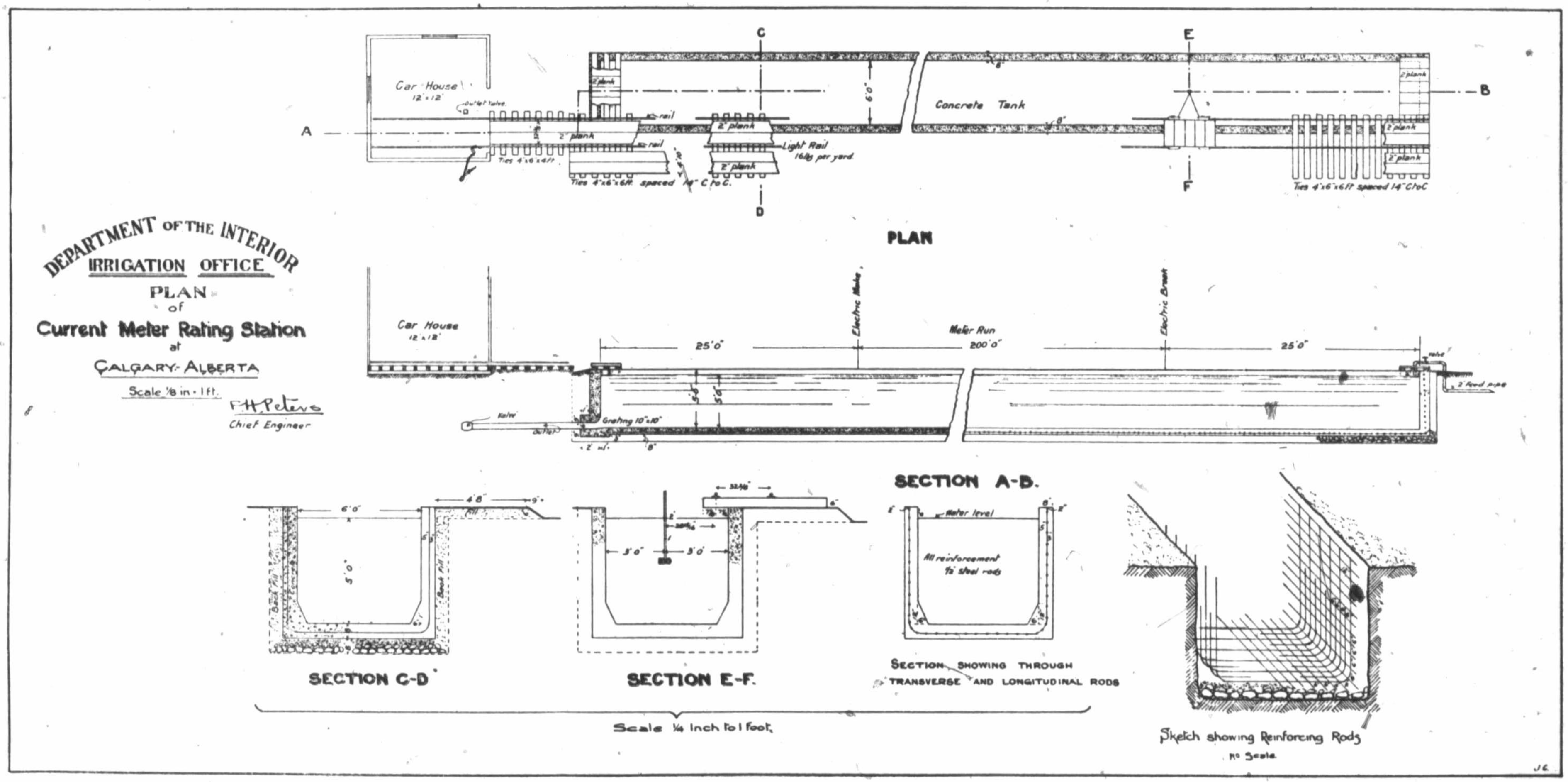
For purposes of keeping a graphical office record of the succeeding ratings of the meters a separate sheet is prepared for each meter. On this is first plotted, for purposes of comparison, the standard curve for the meter (Gurley's standard curve for all Price electric meters) and all succeeding ratings of the meter will be plotted on the sheet in different coloured inks, with notes as to the date of ratings, conditions of the meter, etc., until the confusion of many curves will require the preparation of a new curve sheet. Revolutions per second are plotted as ordinates to a scale of 4 inches to one revolution per second, and velocities in feet per second are plotted as abscissae to a scale of 4 inches to 2 feet per second. For velocities up to 3 feet per second, an auxiliary curve is drawn with the velocity scale increased to 4 inches to 1 foot per second, to allow for greater precision in taking the quantities off the curve.

It is the intention to carry on extensive experimental work in order to determine the various conditions that affect the rating of the current meter. Especially is it desirable to rate every large meter using the two methods of suspension, that is by meter rods and by cable with stay line. With the limited time available during the past season it was possible to rate the meters only with the rod suspension. Some of the results obtained, however, are surprising and worthy of note. The writer has had a lengthy experience with the use of the Gurley No. 600, large electric meter, and his idea has always been (and he knows that it was shared by other men of experience) that with continued use on account of the pivot bearings constantly wearing, the friction was increased, and the revolution of the meter was thereby retarded. The experience of the past summer in rating nine of these meters has indicated that after considerable use the meters run fast instead of slow. The evidence proves, that with considerable use the bearing points in the meter wear themselves smoother than when received from the makers, and hence have less friction than when they are new. The experiments, however, have not been exhaustive enough to prove anything conclusively beyond the fact that, except when they are perfectly new, no current meter can be relied upon unless it is carefully and frequently rated. The new medium size type of electric meter, Gurley's No. 623, has been adopted by this office for the first time this year, and therefore no experiments could be made on worn meters of this type. Five meters of this type were tested, of which two had been in light use for one season and three were perfectly new. All of these gave a rating curve practically the same as the standard curve issued by Gurley's, but in every case showing the meter running a little faster than Gurley's standard.

Of the small electric meters, Gurley's No. 618, nine were tested and all showed nearly the same results, although four of them had been in use for two seasons and five of them were new. At low velocities the new curve coincided with Gurley's standard curve but as the velocities increased the new curve dipped below the standard, which means that the meter was running slower than the standard. This may have been due to the bending at high velocities of the small meter rods by which the meter was suspended from the car. This bending from the vertical of the meter rods was actually noticed to take place, but there was no opportunity to use a stay line to keep the rods vertical, and thereby test the effect of the bending on the rating of the meter. As indicated above, it is the intention to carry on extensive experiments in the future to determine the effect of the method of suspension of the meter on the rating. In practice, all of the large streams are measured by suspending the meter in the stream with a cord and employing a stay line to hold the meter up against the current. Under these conditions, especially with high velocities, there is a tendency for the meter to sway continually from side to side at right angles to the current, and it will be interesting and important to determine what effect this has on the revolutions of the meter. Identical conditions will not be obtainable at the rating station, as the length of the cord suspension will of necessity be much shorter than that used either from a cable car station or from a highway bridge station, and this factor will no doubt enter largely into the amount of sway that the meter will have. Four rating curves are submitted with this paper in order to show graphically actual results obtained in rating meters of different types during the past summer. Explanatory notes have been added (which do not appear on the original office copies) and the curves were selected to show typical cases.

Mr. V. A. Newhall had charge of all the meter ratings during the past season, and under his direction the working parts of the station were put into order and the electric switches and recording apparatus were finally adjusted and improved to overcome difficulties met with in operation. To him, also, the writer is indebted for the notes on the behaviour of the several types of meters on being rated.

In conclusion, the writer would note for the information of members of the Society, that the Irrigation Office is prepared to rate any meters that may be sent in by any engineers or others desirous of having their current meters tested, and a certified rating table will be prepared and returned with the meters. A small fee, based on the salaries paid to the men by the Department, will be charged to cover only the actual time of the engineer and his assistant employed in making the rating and preparing the table.

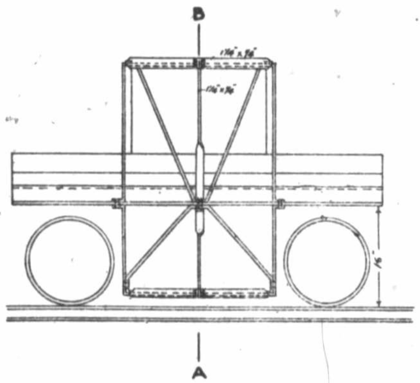

DEPARTMENT OF THE INTERIOR
IRRIGATION OFFICE
PLAN
of
Current Meter Rating Station
at
CALGARY - ALBERTA
Scale 1/8 in = 1 ft.
F. H. Peters
Chief Engineer
Car House
12 x 12
Concrete Tank
Light Rail
16 lbs per yard
2" plank
Ties 4"x6"x6 ft spaced 14" C to C
PLAN
Electric Brake
Meter Run
200'0"
25'0"
Electric Brake
Grating 10"x10"
Valve
Outlet
2" Feed pipe
SECTION A-B.
SECTION C-D
SECTION E-F.
Water level
All reinforcement 1/2" steel rods
SECTION SHOWING THROUGH TRANSVERSE AND LONGITUDINAL RODS
Scale 1/4 inch to 1 foot.
Sketch showing Reinforcing Rods
No Scale

DEPARTMENT OF THE INTERIOR
IRRIGATION OFFICE

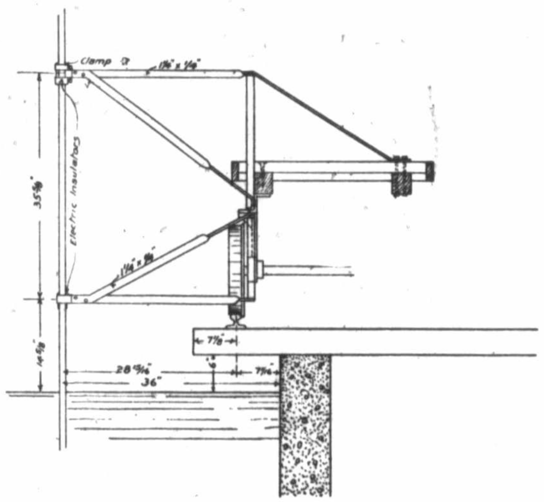
DETAILS OF CAR
for
Current Meter Rating Station
at
CALGARY-ALBERTA

Scale 3/4 in. = 1 ft.

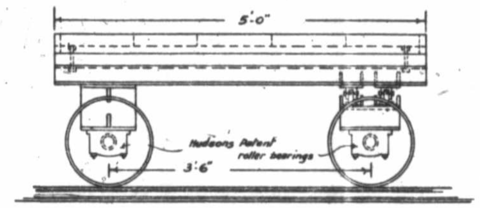
F. H. Peters
Chief Engineer.



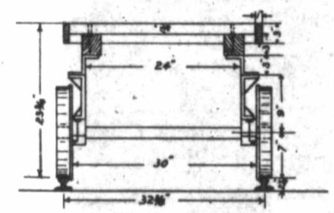
SIDE ELEVATION
Meter suspension rods



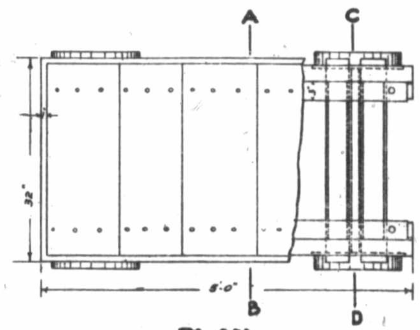
SECTION A-B.
Meter suspension rods



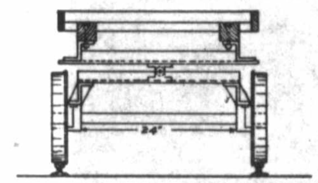
SIDE ELEVATION



SECTION A-B.

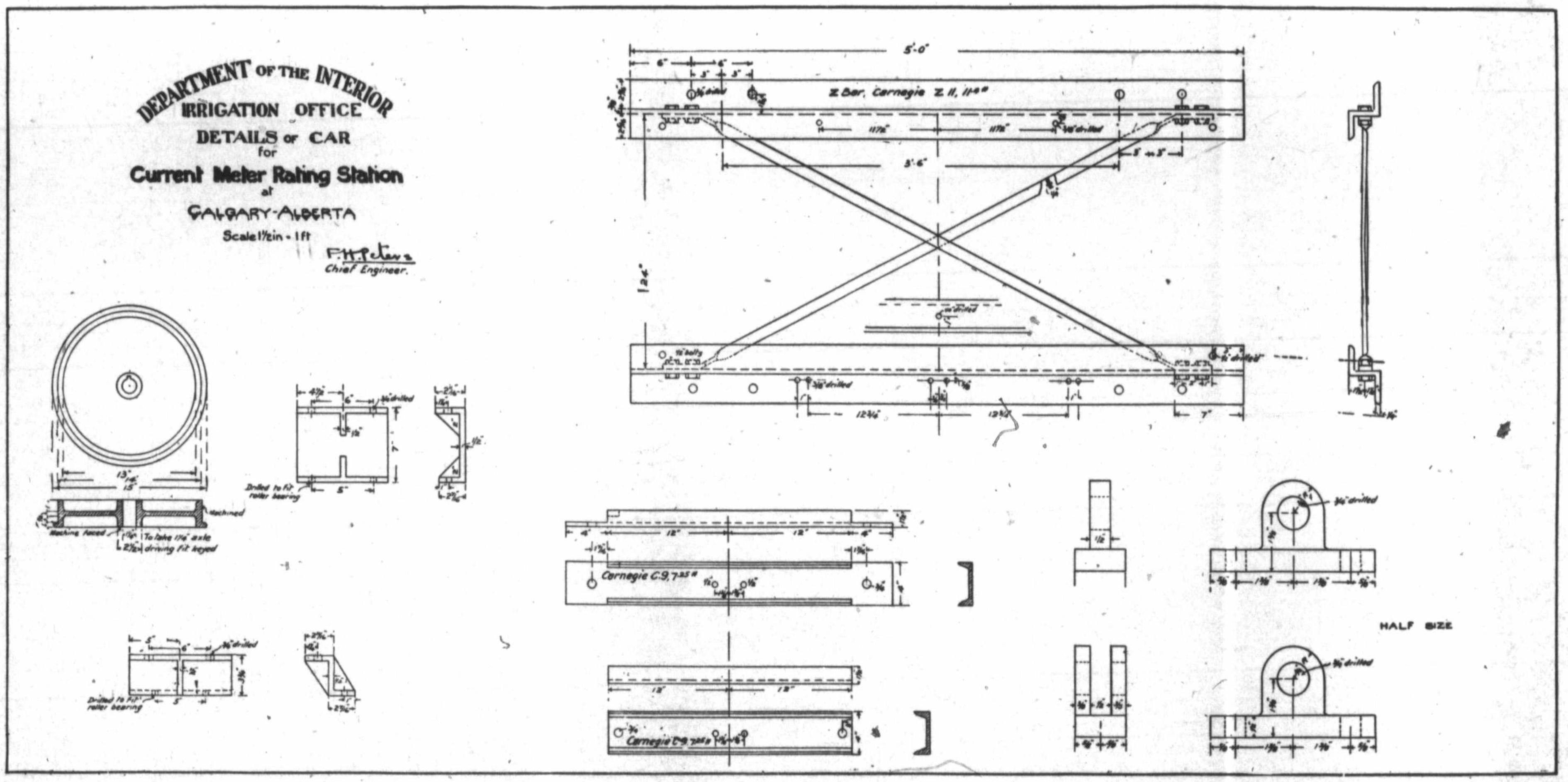


PLAN



SECTION C-D.

J.C.


DEPARTMENT OF THE INTERIOR
IRRIGATION OFFICE
DETAILS OF CAR
for
Current Meter Rating Station
at
CALGARY-ALBERTA
Scale 1½ in - 1 ft
F. H. Peters
Chief Engineer.
5'-0"
Z Bar, Carnegie Z 11, 11.4#
3'-6"
12'-4"
Carnegie C.9, 7.25#
HALF SIZE
Machined
To take 1¼" axle
driving fit keyed
Drilled to fit roller bearing

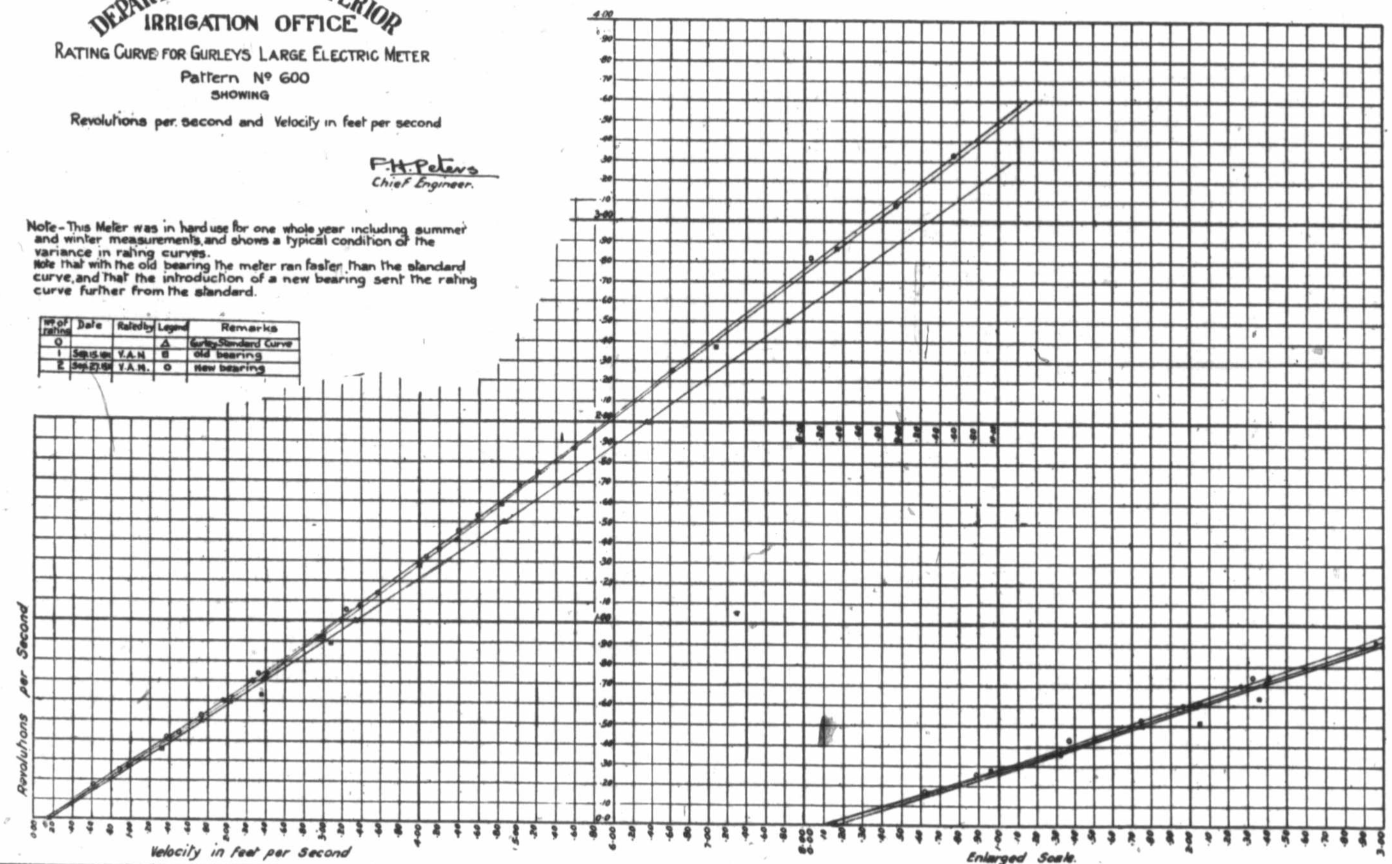
DEPARTMENT OF THE INTERIOR
IRRIGATION OFFICE

RATING CURVE FOR GURLEYS LARGE ELECTRIC METER
Pattern Nº 600
SHOWING
Revolutions per second and Velocity in feet per second

F. H. Peters
Chief Engineer.

Note - This Meter was in hard use for one whole year including summer and winter measurements, and shows a typical condition of the variance in rating curves.
Note that with the old bearing the meter ran faster than the standard curve, and that the introduction of a new bearing sent the rating curve further from the standard.

No. of rating	Date	Rated by	Legend	Remarks
0			Δ	Gurley Standard Curve
1	Sep. 15. 191[illegible]	V.A.N.	⊟	old bearing
2	Sep. 27. 191[illegible]	V.A.N.	o	New bearing



J.G.
24

DEPARTMENT OF THE INTERIOR

IRRIGATION OFFICE

RATING CURVE FOR GURLEYS SMALL ELECTRIC METER

Pattern Nº 618

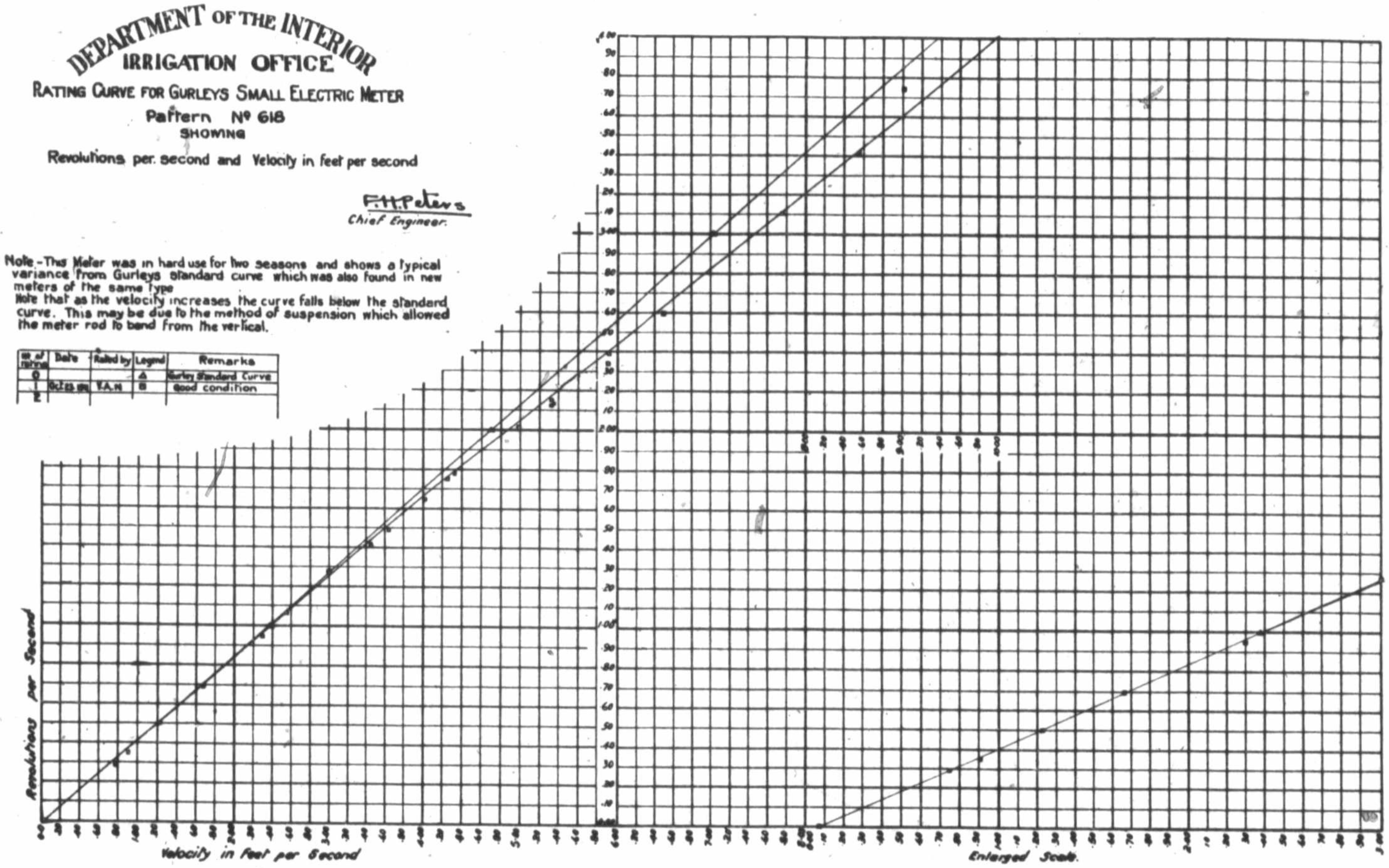
SHOWING

Revolutions per second and Velocity in feet per second

F. H. Peters
Chief Engineer.

Note - This Meter was in hard use for two seasons and shows a typical variance from Gurleys standard curve which was also found in new meters of the same type
Note that as the velocity increases the curve falls below the standard curve. This may be due to the method of suspension which allowed the meter rod to bend from the vertical.

No. of rating	Date	Rated by	Legend	Remarks
0			△	Gurley Standard Curve
1	Oct 23 [illegible]	F.A.N.	⊡	Good condition
2				



J.C.

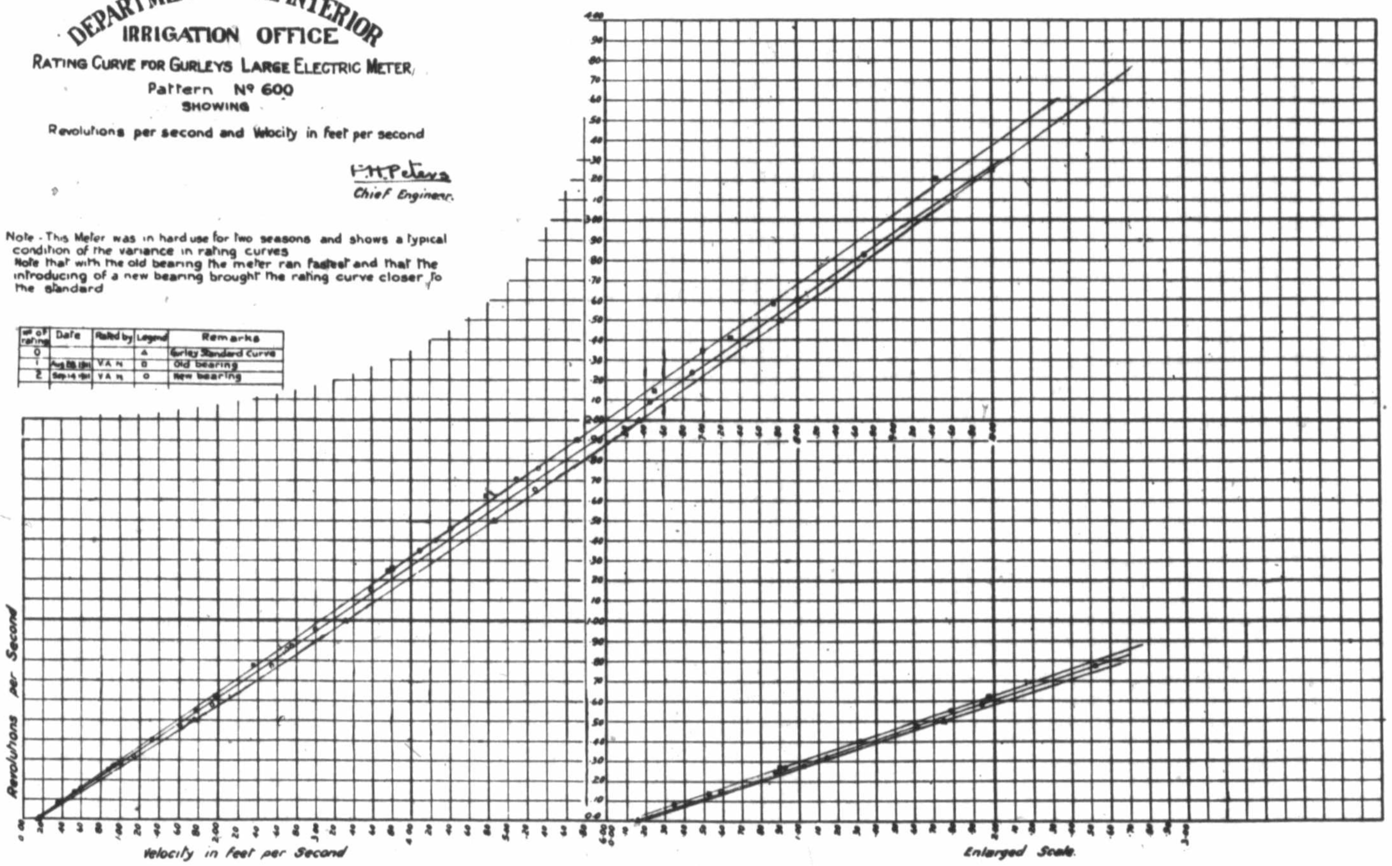
DEPARTMENT OF THE INTERIOR
IRRIGATION OFFICE

RATING CURVE FOR GURLEYS LARGE ELECTRIC METER,
Pattern Nº 600
SHOWING
Revolutions per second and Velocity in feet per second

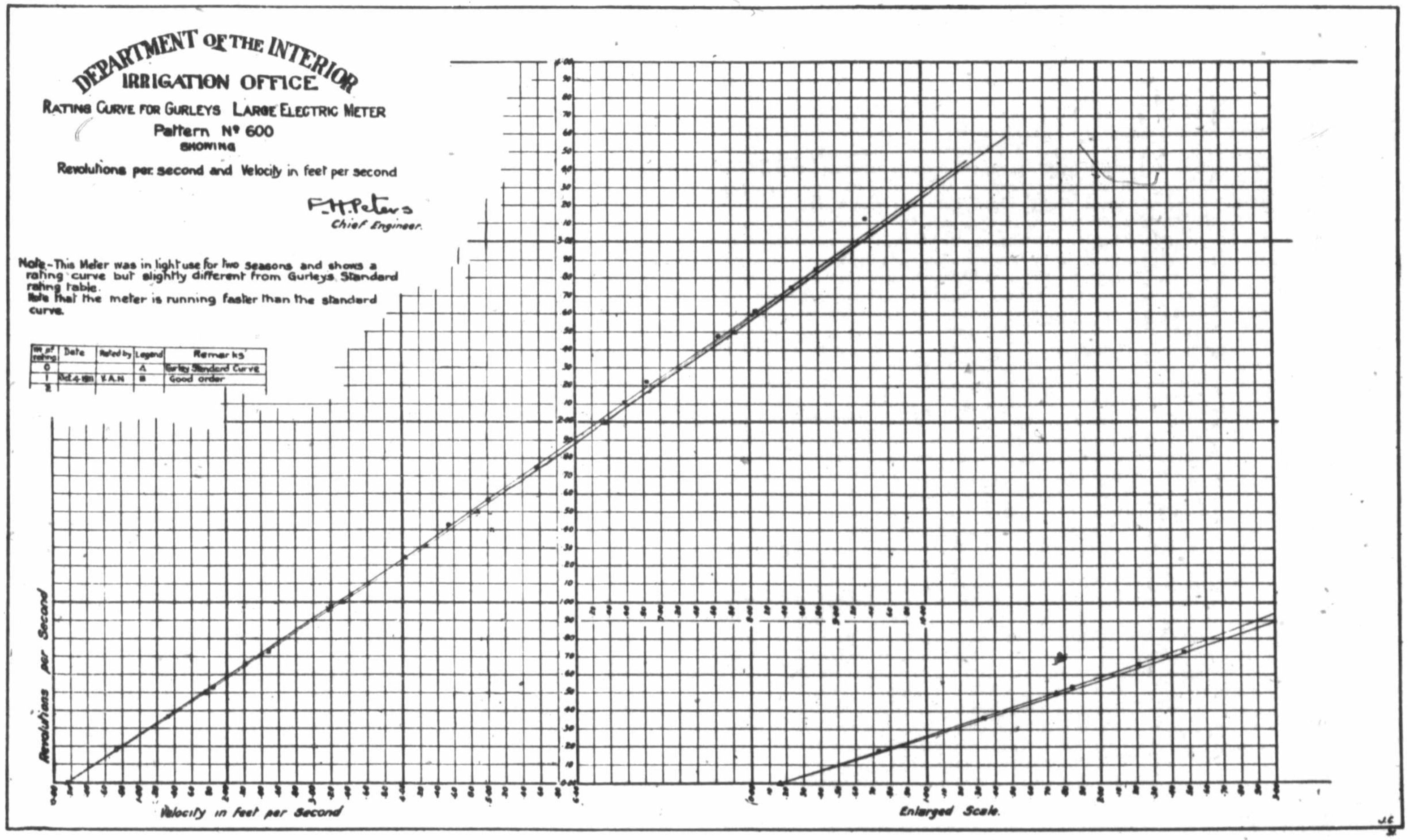
F. H. Peters
Chief Engineer.

Note - This Meter was in hard use for two seasons and shows a typical condition of the variance in rating curves
Note that with the old bearing the meter ran fastest and that the introducing of a new bearing brought the rating curve closer to the standard

Nº of rating	Date	Rated by	Legend	Remarks
0			△	Gurley Standard Curve
1	Aug 28 1911	V.A.N.	□	Old bearing
2	Sep 14 1911	V.A.N.	○	New bearing



J.C.
22


DEPARTMENT OF THE INTERIOR
IRRIGATION OFFICE
RATING CURVE FOR GURLEYS LARGE ELECTRIC METER
Pattern Nº 600
SHOWING
Revolutions per second and Velocity in feet per second
F. H. Peters
Chief Engineer.
Note - This Meter was in light use for two seasons and shows a rating curve but slightly different from Gurleys Standard rating table.
Note that the meter is running faster than the standard curve.
No. of rating | Date | Rated by | Legend | Remarks
0 | | | A | Gurley Standard Curve
1 | Oct. 4 1911 | V.A.N. | B | Good order
2
Revolutions per Second
Velocity in feet per Second
Enlarged Scale.