804

WORTHINGTON

METERS

HENRY R. WORTHINGTON

115 BROADWAY, NEW YORK

U. S. A.

W 800 August, 1914

WORTHINGTON METERS

DUPLEX PISTON PATTERN

DISC PATTERN

TURBINE PATTERN

RECORDING LIQUID WEIGHERS

BRANCH HOUSES:

ATLANTA	Equitable Building
BOSTON	465 John Hancock Building
BUFFALO	898 Ellicott Square
CHICAGO	810 Old Colony Building
CINCINNATI	1503 First National Bank Bldg.
CLEVELAND	Rockefeller Building
DENVER	18th and Lawrence Streets
DETROIT	Majestic Building
SEATTLE	203 Maynard Building
EL PASO	Mills Building
KANSAS CITY	925 Scarritt Building
LOS ANGELES	220 East Second Street
MEXICO CITY	Apartado 5260
NEW ORLEANS	533 Baronne Street
PHILADELPHIA	1516 No. American Bldg.
PITTSBURGH	407 Oliver Building
SCRANTON	715 Connell Building
ST. LOUIS	701 Laclede Gas Bldg.
ST. PAUL	703 Commerce Building
SALT LAKE CITY	115 W. Second So. St.
SAN FRANCISCO	Sharon Building

HYDRAULIC WORKS: HARRISON, N. J.
Established 1840

THE WORTHINGTON HYDRAULIC WORKS
HARRISON, N. J.

The Meter System

The Meter System is now so generally recognized that no argument is necessary to establish its equity and desirability from every standpoint. Meterage is the only possible method of justly apportioning to the users the cost of supplying and distributing water. Any other method adds the cost to the general taxes plus the waste which invariably exists where the meter is absent. Statistics of metered, unmetered and partly metered cities show this latter item to vary from 50 per cent. to 300 per cent. of the cost of furnishing all water really required for use.

Consideration of the subject, therefore, quickly centers on the type of meter to be employed. On the following pages are illustrated and described Worthington Meters of the Piston, the Disc and Turbine types, representing the present highest development of the art of manufacturing machines for measuring water, oil and other liquids, as well as for power plant use on boiler-feed lines.

Worthington Meters have been used for over fifty years, and the sizes and patterns built cover all conditions of service, whether of quantity, pressure, temperature, etc., but only one quality—best described as "Worthington."

When installing meters, users should observe ordinary precautions.

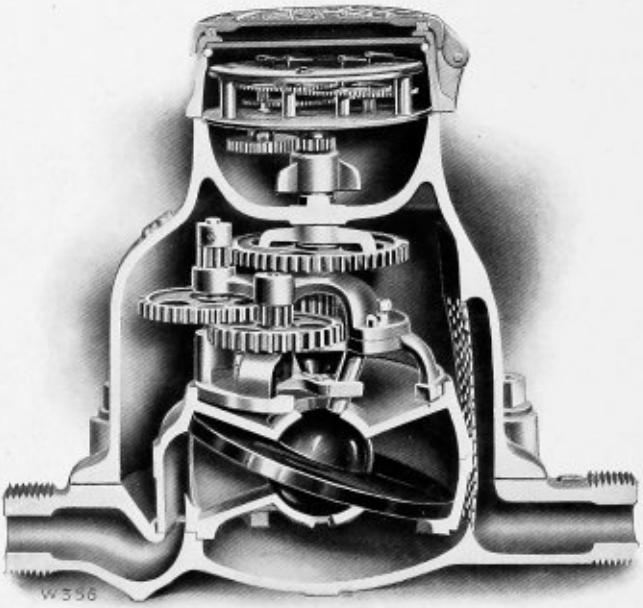
Pipe lines should be flushed out before attaching the meter.

Care should be taken to keep red lead out of the meter.

Where hot water is apt to back up in a pipe line on a cold water disc meter, a swing check valve should be placed in the line on the outlet side of the meter.

Disc Meters may be placed vertically, if desired, but Piston and Turbine Meters should invariably be placed on a horizontal plane.

Hot Water Meters should always be selected with special reference to the particular services upon which they are to be used, and should be frequently cleaned to insure continued accuracy and efficiency.



WORTHINGTON FLAT DISC METER

Sectional Elevation $\frac{5}{8}$-inch, Model D

The Worthington Disc Meter

The Worthington Disc Meter combines minimum weight with reliability on constant service and accuracy of registration.

This Meter represents the most advanced practice, eliminating the weaknesses which have been encountered in the past in other similar meters. It is simple in construction, the workmanship and finish are of the highest grade, and, all parts being made to gauge, are interchangeable. A water-balanced disc is employed, thereby reducing wear to the minimum.

An opening in the bottom of the inner case under the ball bearing of the disc provides egress to the settling basin in the bottom for any fine silt or sand carried by the water. In other forms of construction sand and silt are carried under the ball, causing rapid wear.

The interior case, or measuring chamber, is of brass composition; and the flat disc is of a special hard rubber composition, being moulded under a pressure of 2,000 pounds per square inch.

The top outside casting of the $\frac{5}{8}$-inch, $\frac{3}{4}$-inch, 1-inch, $1\frac{1}{4}$-inch and $1\frac{1}{2}$-inch sizes is made of the best composition, or of iron galvanized, as desired. The covers of the larger sizes are usually of galvanized iron. The bottom casting of the smaller sizes carrying the inlet and outlet spuds are usually made of composition, and the main body or bottom castings of the larger sizes of iron galvanized. However, whenever required, meters of all sizes are made of brass and bronze composition throughout, except, of course, the disc, which is always of hard rubber composition.

In all sizes the pipe openings are on the lower casting. This permits the meter to remain in the pipe line when the top cover has been taken off for examination or cleaning.

The construction of the Meter is such as to lend itself readily to the various forms of "sealing" which are in use in various cities, whether this takes the form of clamps over the couplings, patent sealing couplings, wire and lead seals connected through holes in the main flange bolts, long-head screws on the counter boxes and the coupling nuts, or wax seals stamped with the water department device.

The composition for all of the main castings of Worthington Meters is of a special mixture which is not susceptible chemically to the action of hard and alkaline waters, which are found in many parts of the country, and which composition also resists the action of the traces of acids, which appear in many places. All Worthington Meter castings are made from new mixtures throughout, no scrap metal entering into their composition under any circumstances.

The Worthington Disc Meter

The intermediate train is one of the vital parts in a meter, as upon its accuracy and wearing qualities depend not only the original efficiency of the meter but also the period of its useful life. In the Worthington Meter this feature has received the most careful study and thorough experiment, and the gear train shown in the cut represents a development which gives a combination of light running, accurate transmission of the nutations of the disc to the counter and long wearing qualities never before secured.

From the sectional illustration on page 4 it will be noted that the train is securely anchored upon the disc chamber, thus securing rigid support, and insuring the exact centering of the control with the disc spindle.

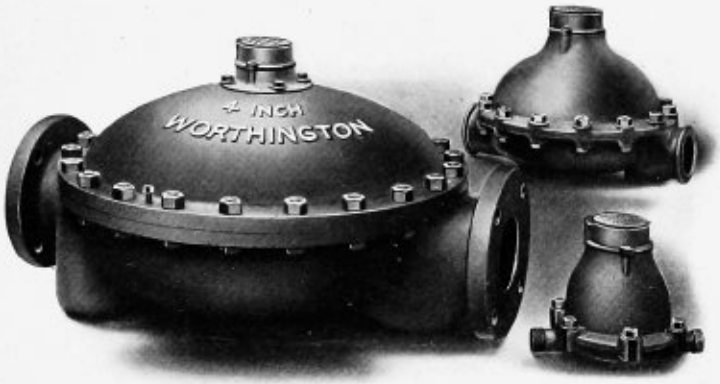
The first spindle, which carries the driving pawl, has a long bearing in the bottom plate and also in the top plate. Both of these bearings have bushings made of fine quality of rubber. This spindle carries a large, heavy, hard metal pinion which engages with the first gear. This first gear, being the fastest running, is made with an extra wide face. The gear has the number two pinion pressed in and the spindle is then pressed in the pinion, making the three parts as one. The spindle has a good wide bearing in the top and bottom plates. Gear number two has the same long bearings in the top and bottom plates.

Number three gear is rubber bushed and is journaled on a boss on the top of the upper plate. Openings in the web of this gear permit of the entrance of the prongs of the intermediate pawl (see sectional cut, page 4).

The train is composed of the fewest possible parts, each designed with regard to highest efficiency in its particular function. The pinions, the gears and the plates are of our special anti-acid composition for this purpose, which also possesses superior wearing qualities. All gears are cut on the most improved hobbing machines and, of course, being made to gauge, are interchangeable.

The Worthington improved counterbox obviates the nuisance of drying out of materials used to hold in the glass, also guards against moisture getting under the glass. This is held in place by a brass wire spring held in a groove and is packed with a rubber gasket. Also, it will be noted that a new glass may be put in place in a moment.

The Worthington Disc Meter



The meters illustrated are the $\frac{3}{4}$-inch, 2-inch and 4-inch sizes. The first shows the $\frac{5}{8}$-inch, $\frac{3}{4}$-inch and 1-inch; the second the $1\frac{1}{4}$-inch, $1\frac{1}{2}$-inch and 2-inch, and the last the 3-inch, 4-inch and 6-inch meters. Every meter is accurately calibrated in the works before shipment, and we are always ready to replace without charge any defective material. Unless otherwise specified, standard straight couplings are furnished with the first three sizes, but no couplings are furnished with larger sizes, unless specially ordered. Sample meters for test and trial are furnished to water works departments where desired.

The following table gives data covering the several sizes which are always carried in stock for immediate shipment.

SIZES AND CAPACITIES OF DISC PATTERN METERS

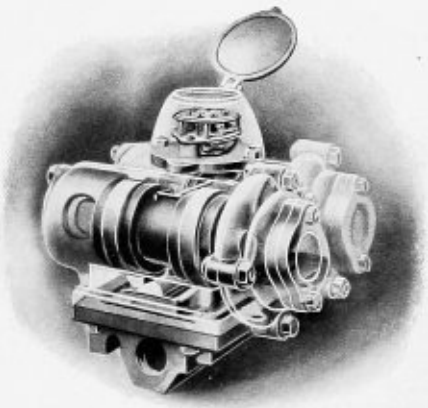
Sizes	Gallons per Minute		Over-All Dimensions			Telegraphic Code Word
	Normal Capacity	Maximum Capacity	Length Inches	Height Inches	Width Inches	
$\frac{5}{8}$-inch	12	15	$7\frac{1}{4}$	$6\frac{1}{8}$	6	Salma
$\frac{3}{4}$ "	24	30	9	$7\frac{3}{8}$	$7\frac{3}{8}$	Salme
1 "	48	60	$10\frac{7}{16}$	$7\frac{3}{4}$	$8\frac{1}{2}$	Salop
$1\frac{1}{4}$ "	60	75	$11\frac{1}{2}$	$8\frac{3}{4}$	$8\frac{3}{4}$	Salla
$1\frac{1}{2}$ "	70	90	$12\frac{5}{8}$	$9\frac{1}{4}$	$10\frac{1}{2}$	Salpe
2 "	115	150	14	10	$12\frac{3}{4}$	Salpo
3 "	200	270	24	13	18	Salqu
4 "	400	540	29	$15\frac{1}{2}$	$23\frac{1}{2}$	Salra
6 "	700	900	36	19	30	Salre

The Worthington Duplex Piston Meter

The Worthington Duplex Piston Meter is of the positive displacement type and has made a record during fifty years of service which has earned for it the reputation "unequalled for accuracy and durability."

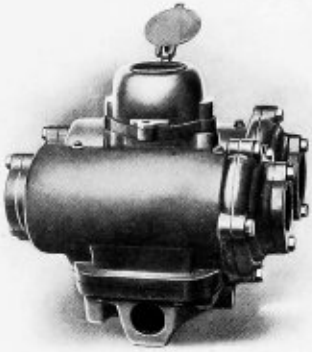
The phantom engraving shows the detailed construction, which in general design is similar to that of the ordinary duplex double-acting pump. As a matter of fact, the first duplex pump ever built was designed by the late Mr. Henry R. Worthington from the Worthington Duplex Meter.

There are two cylinders, in each of which a plunger moves forward and backward through bronze linings, carrying a slide valve over ports in the bottom of the meter. Through these ports the chambers at either end of the plungers are alternately placed in communication with the inlet and discharge openings. One of the plungers imparts a reciprocating motion to the lever, shown near the top of the main casing, which in turn operates the counter movement through the spindle and ratchet, as shown. Thus it will be seen that the counter is arranged to move the dial pointers once for every four strokes of the plungers, and that water cannot pass through the meter without registration for all water going through must enter one or the other cylinder and be displaced by the plungers, and therefore recorded by the movement of the lever and counter mechanism; nor can there be an over-registration, because the plungers cannot move without displacing the fluid in the cylinders.



The Duplex Piston Meter is the only meter having no intermediate train gear in the water. Also, it is the only meter in which the counter will not reverse if the water runs through backward. If the plungers stop the water is cut off and, of course, the meter ceases registering at once, thus necessitating prompt action looking to the removal of the cause of interference with the registration.

The Worthington Duplex Piston Meter



This meter is particularly adapted to large and heavy water works service. The main body casting, bottom, cap and heads are made of the best quality cast iron; the cylinder linings, plungers, slide valves and valve seat are made of a special brass composition, as are also the lever, spindle, spindle stuffing box and ratchet movement. There is no gearing in the water, as the slow motion of the moving parts obviates the necessity for an intermediate train between the measuring chambers and the counter. This meter is not affected by the warm water which sometimes backs up in service pipes, a feature appreciated by all water works.

The standard meter is designed for working pressures up to 125 pounds. Heavy pattern meters for 175 pounds pressure are furnished at small additional cost.

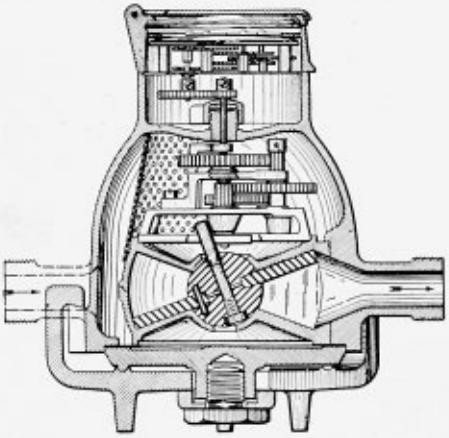
SIZES AND CAPACITIES OF GENERAL SERVICE METERS

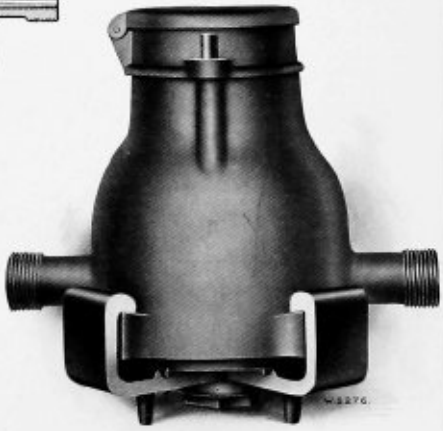
Size of Opening	Gallons per Minute Maximum	Over-All Dimensions			From Face to Face of Inlet and Outlet Openings	Telegraphic Code Words	
		Length Inches	Width Inches	Height Inches		Meter	Brass Couplings
⅝-in. pipe	11½ gals.	15	9	13	7¾	Sabaj	Sabun
¾ "	22½ "	17	13	15	9½	Sabay	Sabus
1 "	37½ "	20	15	16	10¾	Sabbi	Sacal
1¼ "	45 "	17	16	17	11⅜	Sabel	Sacca
2 "	60 "	19	16	17	11⅞	Sabin	Sacch
3 "	172 "	25	22	21	15½	Sabog	Sacel*
4 "	450 "	37	34	36	25⅛	Sabor	Sacho*
6 "	900 "	51	49	48	42	Sabta	Sacku*

* Screw Flanges.

Intermediate Train

Frost-Clamps





¾-INCH MODEL F FROST-PROOF METER

Patent Applied for

The Worthington Frost-Proof Meter

Frost-Proof

When the water is frozen, one or more of the breaking frost-clamps give way, relieving the pressure and protecting the meter from damage.

Cost of New Parts

Five to twenty cents.

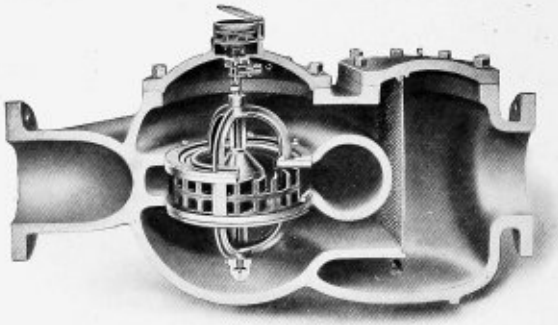
After Freezing

After the Worthington frost-proof meter has been frozen and one or more of the iron frost-clamps have been broken out, it is only necessary to snap into place new clamps. There are no other repairs required. It is not necessary to open up the meter, nor to have it re-calibrated.

Construction

All parts coming into contact with the water are made of non-corrosive composition or rubber. The bottom plate is covered with a rubber gasket. Only one large tap bolt in the bottom is used to set up the frost-clamps. No other bolts are used inside or outside. This is a full capacity meter, of unusually heavy and substantial construction, insuring greatest durability; it is sensitive in its operation, securing the highest accuracy.

The Worthington Turbine Meter



Section Through 6-Inch Size

The Worthington Turbine Meter is a development of the well-known Worthington Turbine Pump. It is of the current or "velocity" type, designed primarily to handle large volumes of water with minimum loss of pressure. Remarkably sensitive on the smaller flows, it satisfies demands at both extremes of the most exacting service.

From the sectional cut, it will be seen that the water enters the main casing through a slide strainer. The column then divides, flowing to both sides of the double wheel, which carries two sets of vanes. Thus an absolute water-balance is secured, and the end thrust and consequent wear which occur in those forms of construction employing only one set of vanes on the wheel is eliminated. This point is vital to continued accuracy and durability in the meter.

The wheel is surrounded by a chamber of the volute pattern, providing at all points of the circumference the exact cross-sectional area necessary to handle the amount of water discharged by the wheel, at the same time conserving the speed of the water column. The wheel is of special hard rubber composition, of practically the specific gravity of water, and is carried on a vertical shaft of Tobin bronze, which turns on a jeweled bearing.

Owing to the water-balance mentioned, the friction at this point is slight, being only that due to the small excess weight of the wheel and shaft over that of the water displaced. The meter presents no other contact or wearing surface, outside of the clock gearing; the main outer castings never wear and a meter of this type may be regarded as a permanent installation, as practically the only parts subject to wear are the counter, gearing and the shaft bearing.

Special attention is directed to the simplicity and convenience of general construction. The strainer is reached through a separate hand-hole plate, and the casing is of liberal dimensions, permitting of easy cleaning. Removing the main cover, the working parts may be at once lifted out for examination or repair. This is accomplished without breaking the joints or in any way disturbing the main body casing in its position in the pipe line.

The Worthington Turbine Meter

8-Inch Size

When installing large meters, it is customary to surround them with a by-pass, so that in the event of any accident to the meter the flow of water would not have to be cut off. This form of installation is not essential with the Worthington Turbine Meter, as, when the moving parts have been taken out for examination or repair (as explained on the opposite page) and the cover replaced, the water may be passed through the main casting as a part of the pipe line.

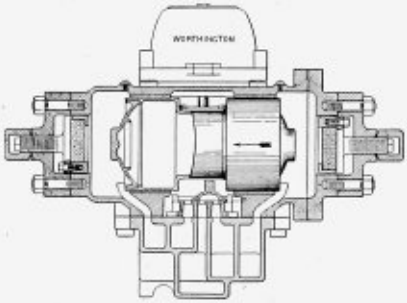
The 2-inch size has the openings tapped for standard iron pipe thread, and the 3-inch and larger sizes have the openings flanged, as shown by the cut. Screwed companion flanges will be furnished with the 3-inch, 4-inch and 6-inch sizes where desired. The following table gives data covering the standard sizes usually carried in stock. These meters are designed for a working pressure of 150 pounds per square inch. Special meters are furnished, at small additional cost, for working pressures up to 250 pounds per square inch.

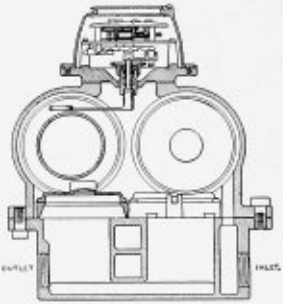
SIZES AND CAPACITIES OF TURBINE METERS

Sizes	Gallons per Minute		Over-All Dimensions			Telegraphic Code Word
	Normal Capacity	Maximum Capacity	Length Inches	Width Inches	Height Inches	
2-inch	150	250	16¾	9	12½	Sucra
3 "	350	550	24	12	13	Sudsu
4 "	700	1000	27	16	16	Sufra
6 "	1500	2200	36	22	20	Sugle
8 "	3000	4000	48	29	20	Suhra
10 "	4500	6000	60	35	29	Sulgu
12 "	6500	9000	70	42	31	Supke

Worthington Duplex Piston Hot Water Meter

FOR BOILER TESTING





The Worthington Hot Water Duplex Piston Meter is essential to the proper testing of a boiler plant. It is also an invaluable adjunct in trying out the steam-making value of different fuels. For the continuous measuring of large volumes of hot boiler feed water under pressure we recommend the Turbine Hot Water Meter, shown on page 17.

The Duplex Piston Meter, as will be seen from the sectional cut, is practically the water end of a duplex double-acting pump, having the cross-over valve motion in the bottom. The moving parts consist of two plungers and two slide valves with a lever which conveys the motion of the plungers to the recording mechanism. The ends of the cylinders are fitted with adjustable tappets. By screwing these in or out, the length of the plunger stroke, and consequently the displacement per registration on the counter, may be altered. This provides means for calibrating the meter for any service, as explained on page 15. No adjustment is possible in any other form of measuring apparatus.

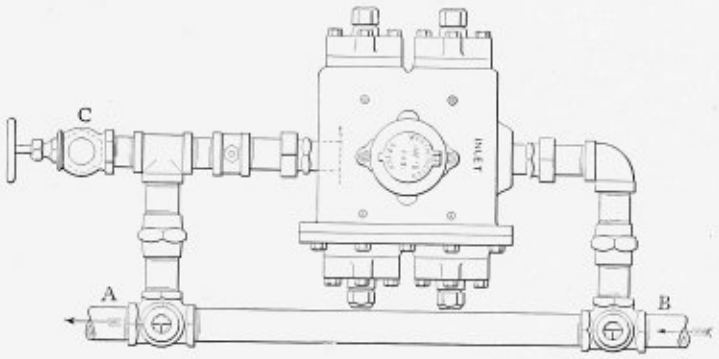
This meter is regularly made with the main casting of iron galvanized and bronze-lined, and the plungers of hard, close-grained cast iron, or of brass composition, as may be specified. This form of construction is offered for any working pressure up to 175 pounds per square inch, and any temperature to the boiling point. Special meters, with the main body castings of composition, are furnished for any working pressure to 200 pounds, and any temperature to 250 degrees.

SIZES AND CAPACITIES OF DUPLEX PISTON TEST METERS

Sizes	Maximum Horse-Power of Boilers	Telegraphic Code Words	
		Meter	Test Fittings
$\frac{5}{8}$-inch	60	Sadar	Sagar
$\frac{3}{4}$ "	120	Saded	Sagen
1 "	175	Sadel	Sagfo
$1\frac{1}{2}$ "	225	Sadfa	Sagho
2 "	300	Sadgo	Sagin
3 "	800	Sadha	Sagko
4 "	2500	Sadir	Sagla
6 "	5000	Sadke	Sagma

Worthington Duplex Piston Hot Water Meter

FOR BOILER TESTING



By-Pass Connections

Hot Water Test Meters should be connected on a by-pass, as shown by the cut. The advantages of this arrangement are obvious, as the meter may be thrown in or out of service as desired, without interrupting the flow of the water to the boilers, and may be calibrated under the actual running conditions without breaking the piping. The meter should be placed in the main feed line, between the pump and the heater, if possible. If all of the piping is not in the same plane the meter should be located at the lowest point. The cut illustrates the most direct and simple method of making this installation. The test fittings consist of two three-way valves, one angle valve, thermometer and brass holding cup for same, and the necessary pipe, elbows and unions.

To test the meter when connected in this way, and referring to the cut, set the three-way valves "A" and "B" to shut off the main line to the boiler and to pass water through the meter; open the angle valve "C," from which a connection may be made to a cask or tank on a platform scale. The relation between the weight of water as shown by the scale and the counter reading, taken in connection with the temperature of the water (see table on page 40) gives in a percentage, plus or minus, the correction to be applied to the counter reading. Or the meter may be adjusted to an exact balance by screwing in or out the tappets in the end of the cylinders, as may be necessary to alter the plunger displacement, when the counter reading may be accepted as final.

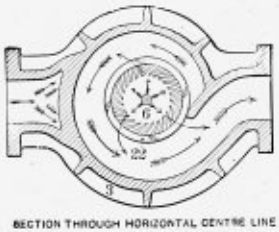
When calibrating a meter of large size on a small quantity of water, it is to be noted that the counter moves only once for each complete revolution of the plungers; that is, each plunger must take one stroke forward and one stroke back before the counter moves once, and, therefore, it is essential that the plungers should be started and stopped in the same relative position in order to secure accurate results from the tests.

It will be seen from the above that this meter may be calibrated after having been piped up, under the running conditions, so that all parties interested in the test may be satisfied by actual demonstration of the accuracy of the meter.

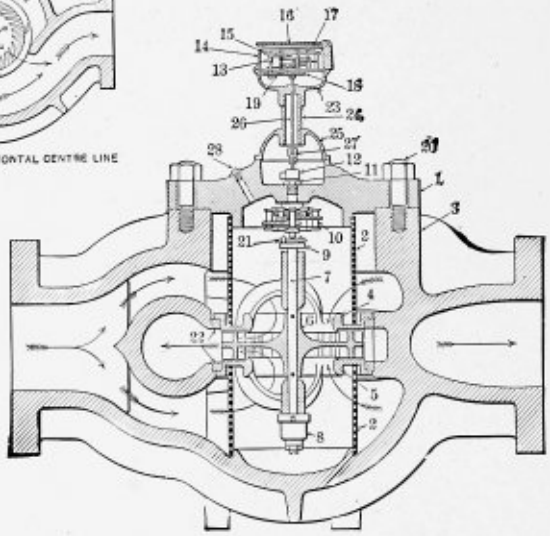
In all tests for the comparative values of different fuels, or to determine the efficiency of a boiler plant, the absolute certainty of the amount of water evaporated by the boilers is an invaluable consideration.

The Worthington Turbine Boiler-Feed Meter

HEAVY PATTERN—FOR HOT WATER



SECTION THROUGH HORIZONTAL CENTRE LINE



A hot water meter is an essential element of boiler plant economy. It is of little value to weigh the coal if the feed water is not measured. Its use solves the difficulty of readily ascertaining the steam-making values of different fuels. If the boiler is overtaxed, or affected by scale or soot, the method of firing inefficient, the furnace defective, or the coal of inferior quality, the fact is reflected immediately in the registration of the meter.

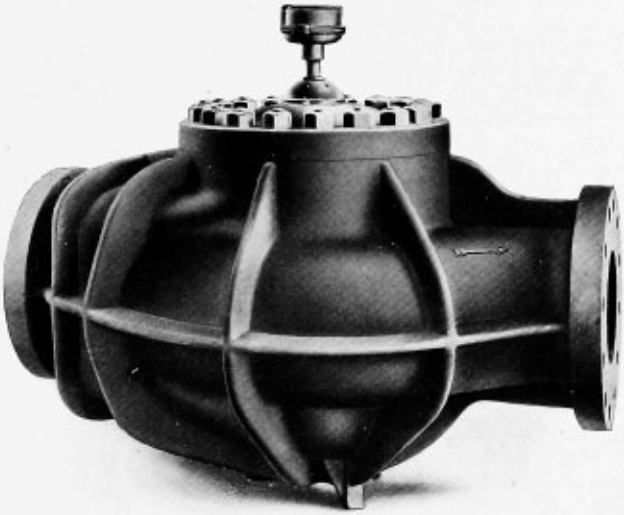
For the continuous measuring of hot boiler-feed water under pressure, the Worthington Special Hot Water Turbine Meter is recommended. This meter is particularly adapted to this very severe service on account of the absence of bearing and wearing surfaces, the only point of contact outside of the clock gearing being the jeweled bearing which carries the vertical shaft and wheel. The wheel is double and water-balanced, eliminating end thrust. Consequently, the friction at this point is reduced to a minimum. Practically the only parts in the meter which are subject to wear are the bearing points mentioned, and the intermediate gear-train, and these may be readily and cheaply replaced.

The wheel is of spun copper, making it impervious to the chemical action of boiler compounds which are frequently pumped through with the feed water, and as the wheel itself has no bearing surfaces it is not subject to wear.

Turbine Meters are sensitive, accurate within the limits of their capacities and unusually durable. They may be absolutely depended upon for a continuous record of performance of the boiler plant.

The Worthington Turbine Boiler-Feed Meter

HEAVY PATTERN—FOR HOT WATER



Hot Water Meters should always be selected with a view to all the conditions of the service, and not for the maximum capacity only. Where the quantity of steam drawn from the boilers varies greatly during different periods of the day, it is advisable to install two meters of a size smaller than required for the maximum capacity; these meters to be connected on a "Y" and only one used for the smaller flows. When advised as to full details of the service we will recommend the proper installation. We should know the maximum actual developed horse-power of the boilers, extreme variation of the service, temperature and pressure.

The meters are designed for any working pressure to 250 pounds per square inch, and any temperature to 250 degrees. Each meter is calibrated in the shop for the special service for which it is intended.

SIZES AND CAPACITIES OF HOT WATER TURBINE METERS

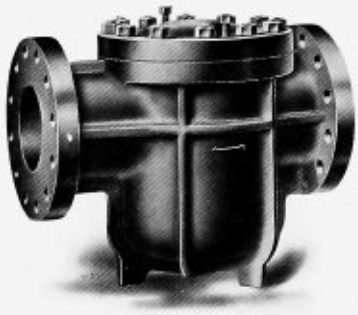
Sizes	Capacity Horse-Power of Boilers	Over-All Dimensions			Telegraphic Code Word
		Length Inches	Width Inches	Height Inches	
2-inch	200 to 700	15	10	17	Surba
3 "	500 to 1500	21	14	20	Susdo
4 "	1200 to 3000	24½	19	23	Sutfe
6 "	2500 to 6000	32	26	27	Suvhu

Installation and Care of Hot Water Meters

For constant service on a hot water boiler feed line the Turbine Meter should be installed in the main line, on the discharge side of the pump, in a horizontal plane, at a low point in the pipe line, and there should always be a separate strainer in the line on the inlet side of the meter. An installation of this character should always be properly proportioned for the minimum as well as for the maximum service. For example, a 1,000 horse-power boiler plant which operates six days a week and ten hours a day at its maximum capacity, or at an overload, and which has a night and Sunday load of possibly only 50 or 100 horse-power, should be equipped with a meter of suitable size on the main line, separate strainer, and a small meter on a by-pass for the light loads, this being connected into the main line with a couple of three-way valves, so that it may be instantly thrown in or out of service. Also, the turbine meter should be kept clean.

Other possible variations in the installation are referred to on page 17.

The Worthington Strainer for Heavy Pressure



This line of strainers is designed for a working pressure of 250 pounds per square inch, and, while especially designed for use in connection with the heavy pattern Turbine Meter, is suitable for any other situation where it is desirable to strain water under heavy pressure. Such a strainer may be readily cleaned, and this can be done in a few minutes and without trouble. The use of a strainer goes far to insure a clean and, therefore, an accurate meter, and also helps to keep foreign material out of the boiler.

TABLE OF SIZES AND CAPACITIES

Sizes	Length Inches	Height Inches	Base to Center of Opening Inches	Flanges			Telegraphic Code Word
				Diameter	Bolts	Circle	
2-inch	13	$7\frac{1}{2}$	$3\frac{5}{8}$	$6\frac{1}{2}$-inch	$4\frac{5}{8}$-inch	5 -inch	Tacad
3 "	$13\frac{1}{4}$	$11\frac{5}{8}$	$6\frac{7}{8}$	$8\frac{1}{4}$ "	$8\frac{5}{8}$ "	$6\frac{5}{8}$ "	Tador
4 "	16	$13\frac{3}{8}$	$8\frac{1}{2}$	10 "	$8\frac{7}{8}$ "	$7\frac{7}{8}$ "	Tafad
6 "	$21\frac{1}{4}$	$18\frac{1}{2}$	$11\frac{1}{4}$	$12\frac{1}{2}$ "	$12\frac{7}{8}$ "	$10\frac{5}{8}$ "	Tagos

Fish Trap or Separate Strainer

Cut Shows ⅜-inch, 4-inch and 10-inch Strainers

Where separate fish traps or strainers are desired, the type shown by the cut will be found most convenient, as it will be seen that the strainer, when once connected in the pipe line, can be cleaned when the cover has been removed, without the necessity of breaking the pipe connections.

The strainer proper consists of two cast brass slotted plates, which rest in vertical grooves. The total area through these slots is more than the area of the pipe line. The plates may be readily taken out and cleaned.

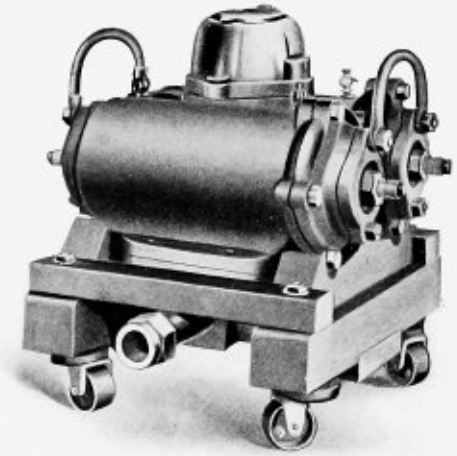
The ⅝-inch, ¾-inch, 1-inch and 1½-inch strainers have the openings tapped for standard pipe thread; the larger sizes are flanged.

Special attention is directed to the fact that the Worthington Disc Meters are provided with interior strainers, and that, therefore, separate fish traps are not usually required. Cold water Turbine Meters also have strainers placed in the main body castings.

SIZES OF STANDARD STRAINERS

Sizes	Length Inches	Height Inches	Base to Center of Opening Inches	Flanges			Telegraphic Code Word
				Diameter	Bolts	Circle	
⅜-inch	7	5⅜	2⅜	.....	.....	.....	Tabac
¾ "	7	5⅜	2⅜	.....	.....	.....	Tabad
1 "	7	5⅜	2⅜	.....	.....	.....	Tabag
1½ "	7	5⅜	2⅜	.....	.....	.....	Tabae
2 "	9	6½	3½	.....	.....	.....	Tabal
3 "	13	10 1/16	6 1/16	7½-in.	4¾-in.	6 -in.	Tabam
4 "	15¼	12¼	7½	9 "	4¾ "	7½ "	Taban
6 "	20	16½	10½	11 "	8¾ "	9½ "	Tabap
8 "	22	17¾	8¾	13½ "	8¾ "	11¾ "	Tabax
10 "	28	22⅜	11½	16 "	12¾ "	14¼ "	Tabby
12 "	32	27¾	14½	19 "	12¾ "	17 "	Tabaf

The Worthington Duplex Piston Beer Meter



For measuring hot or cold beer, the Adjustable Duplex Piston Meter is specially adapted. It is made of the best bronze composition throughout, and on account of the adjustable tappets in the cylinder heads may be calibrated for any service.

The counter reads in barrels, and vent cocks are provided for the escape of air or gas. As shown in cut, these meters are mounted on trucks on wheels for convenience in moving from one vat to another.

The construction is exceedingly simple, being practically the liquid end of a pump. The moving parts consist of two plungers and two ordinary slide valves. The meter being of the positive displacement type, absolute accuracy of registration is assured at all flows and under all conditions.

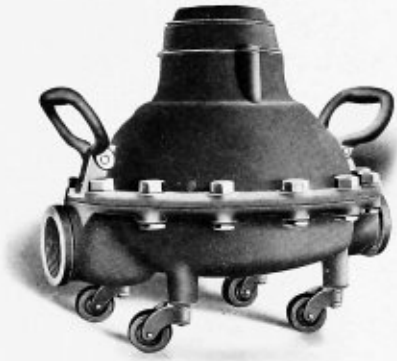
No brewer can afford to be without a Beer Meter. It is invaluable in connection with checking up the daily output.

SIZES AND CAPACITIES OF WORTHINGTON BEER METERS

Size of Opening	Quantity per Minute on Constant Service	Over-All Dimensions			Telegraphic Code Words	
		Length Inches	Width Inches	Height Inches	Meter	Special Truck
½-in. pipe	4 Gallons	17	10½	13	Sarba	Sarla
¾ "	8 "	19	13	15	Sarbe	Sarlu
1 "	12 "	23	15	18	Sarbo	Sarma
1½ "	16 "	20	18	20	Sarce	Sarme
2 "	20 "	21	17	21	Sarca	Sarmu
3 "	60 "	28	22	25	Sarcu	Sarpa
4 "	175 "	41	34	42	Sardi	Sarpu
6 "	350 "	60	49	56	Sarde	Sartu

The Worthington Beer Meter

DISC PATTERN



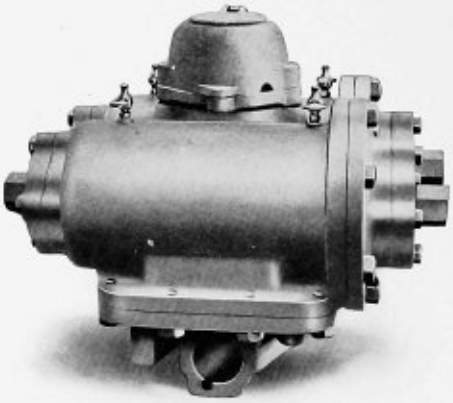
For measuring hot or cold beer, special Beer Meters are furnished, made of brass throughout. These are mounted on wheels for convenience in moving from one vat to another. Polished brass handles and brass couplings or flanges are part of the regular construction. The counter is of the three-circle type, reading 1, 30 and 300 barrels.

The use of these meters in a brewery affords the most simple, accurate and convenient method of regulating and controlling the daily output.

SIZES AND CAPACITIES OF DISC PATTERN BEER METERS

Size of Opening	Capacity in Gallons per Minute	Over-All Dimensions			Telegraphic Code Word
		Length Inches	Width Inches	Height Inches	
½-inch	15 Gallons	7¾	5⅜	6½	Socor
¾ "	30 "	9	7	7	Sodan
1 "	60 "	10⅞	8	7	Sofur
1½ "	90 "	12⅝	10¼	11¼	Sogor
2 "	150 "	16½	12	13½	Soman
3 "	270 "	24	17½	16	Sopur

The Worthington Duplex Piston Oil Meter



For measuring crude oil, petroleum and naphtha from and into tanks, or from wells, and for recording the amount of oil used in connection with oil-burning apparatus, the Worthington Duplex Piston Oil Meter is indispensable.

We are manufacturers of all types of meters, but in our experience the only form of construction which is accurate and reliable for oil measuring purposes is the positive displacement machine of the piston type.

These meters have extra wide flanges and are fitted with metal buffers in the heads. The cylinders are provided with air cocks at the top, which should be opened at intervals when the meters are worked on such fluids as naphtha, benzine, kerosene, etc., to release any gas which may collect in the cylinders.

The ends of the cylinders are fitted with adjustable tappets, which are shown in the illustration. By screwing these in or out, the length of the plunger stroke is altered. This permits the exact calibration of the meter for any varying conditions of service, and the meter may, therefore, be calibrated as often as thought necessary under the actual working conditions. This feature of adjustment after the meter has left the factory is found in no other measuring apparatus.

All of these meters are designed for a working pressure of 175 pounds per square inch.

TABLES OF SIZES AND CAPACITIES

Size of Meter	Quantity per Minute on Constant Service	Telegraphic Code Word
½-in. pipe	1 Gallon	Sanbo
⅝ "	4 Gallons	Sanbu
¾ "	8 "	Sanca
1 "	12 "	Sancu
1½ "	16 "	Sangu
2 "	20 "	Sanba
3 "	60 "	Sanpe
4 "	175 "	Sanra
6 "	350 "	Sansa

NOTE.—The ½-inch size is made only of brass composition throughout.
The ⅝-inch has the inlet and outlet openings tapped for standard ½-inch pipe thread.

Duplex Piston Oil Meter

INSTALLATION

The meter should be set in a horizontal plane with the inlet pipe connected to the inlet opening, and preferably at the low point in the pipe line. There should be a net pressure at the inlet opening of not less than five pounds per square inch for the smaller sizes and eight pounds to ten pounds for the four inch and six-inch sizes in order to secure the full ratings specified in the table on page 22. No special foundations are required, nor is any adjustment necessary. The meters are tested before being shipped from the factory.

OPERATION

No special care or attention is required in connection with the operation of a Duplex Piston Oil Meter, unless the oil handled is of such a character as to clog up the ports or to make a deposit on the moving parts, when, of course, the meter should be blown out as often as necessary. When first started up the air cocks in the top of the cylinders should be opened, and as soon as the fluid appears should be closed. Also, when the meters are operated on such fluids as benzine, naphtha, etc., these valves should be opened at intervals to free the meter of gas, as the collection of gas in the cylinders, of course, interferes with the accuracy of registration.

CALIBRATION

When it is desired to test and calibrate a meter, a quantity of oil or water should be passed through equal to a complete revolution of the hand on the first circle, the fluid being carried into a cask or tank on a platform scale. Then if the excess weight in the tank does not coincide with the counter reading, the meter may be brought into exact balance with the counter reading by lengthening or shortening the plunger stroke. This is accomplished by screwing in or out the adjustable tappets in the ends of the cylinders. All four tappets must be moved evenly so as to keep equal plunger stroke both sides of the center. Usually a one-quarter or one-half turn on the tappets would take care of any small variation in the service.

Meters should not be tested on quantities smaller than mentioned, if exceedingly accurate results are required, as the counter only moves once for each complete revolution of the meter, or four single strokes of the plungers, and if tests are made on small quantities, care should be taken to see that the plungers are started and stopped in the same relative position.

TO READ THE COUNTER

The counter is read the same as the ordinary gas meter register. The first or right hand figure of the answer is taken from the circle marked "10," the second figure from the circle marked "100," and so on. When a pointer is between two figures, the smaller must be taken, as it is obvious that the pointer is traveling towards the larger figure and has not reached it.

Dials of 4-inch and 6-inch meters have the first circle reading 100; therefore, the first and second figures of the answer are to be taken from the first circle on these dials. In other words, if the hand is between the 3 and the 4 on the first circle of such dials, the answer is 30. When one pointer is so near a figure as to indicate it exactly, look at the circle next lower in denomination, and if the pointer on that circle has passed the "0," then the count should be taken for the figure which the hand on the higher circle seems to indicate, but not otherwise.

NOTE.—In ordering parts, the size and serial number of the meter must be given, in addition to number of part as found in above list.

Testing of Water Meters

The only reliable method of testing meters for accuracy is by weighing a quantity of water drawn through the meter, and comparing this quantity with the counter reading. Many water departments are now provided with especially designed testing apparatus, but where such facilities are not available the following points should be observed, especially when testing meters of the current type.

A full flow of water should come into the meter itself, the rate of flow to be regulated by a valve on the outlet side. This insures the meter being always full of water and under pressure as in regular service on a pipe line. Whenever possible, a quantity of water at least equal to a complete revolution of the hand on the first circle of the counter should be measured, as readings of fractions of the first circle are not sufficiently accurate for the purposes of a test on small quantities of water. When testing current meters of large sizes without proper facilities, great care should be exercised in reading the counter the instant the flow of water is cut off.

Disc and Turbine Meters, which have been repaired locally and do not test accurately, may be corrected by substituting change gears between the counter and intermediate train. Piston Meters are similarly corrected by removing or putting in paper packings behind the buffers, thus altering the plunger stroke.

Hot Water Meters are built with proper allowances for expansion of the parts. Such meters should be tested only on hot water, as with cold water there would naturally be some slippage.

All new and repaired meters are tested in the factory, and no meter is shipped until it fully meets the standard requirements for that particular size and type.

Worthington Meters may be calibrated to meet any special test requirements of any water department, and such special calibration will be cared for without extra charge when the specifications are on the original order.

Meter with Elevated Counter

Where meters have to be placed below the surface of the ground or in other positions difficult of access for the purpose of reading the counter, it is convenient to have the meters fitted with an extension counter fitting, as shown by the accompanying illustration. These extension counter fittings are made so that they may be applied to any size or type of meter, either new or now in service.

The fittings are made standard in four sizes, 18-in., 24-in., 30-in. and 36-in. high; that is, the figures given indicate that the top of the counter box is just so much higher than it would be as regularly placed on a standard meter. If the standard heights specified do not meet any particular case, special fittings will be supplied of any desired height, but, of course, at a somewhat additional cost.

The standard lengths are always carried in stock and are inexpensive.

In ordering meters with elevated dials, it is necessary that the exact extra height desired should be specified. When setting meters with elevated dials, it is essential that the meter should be so placed as to protect the extension fitting against injury.

FIG. 1

14,435 Cu.Ft.

Fig. 2

16,062 Cu. Ft.

Fig. 3

9,471,307 Cu.Ft.

Fig. 4

1,537,900 Cu.Ft.

Fig. 5

Fig. 6

Figures 1, 2, 3 and 4 show standard circle counters in general use.
Figures 5 and 6 show standard type of straight reading counters.

Instructions for Reading Counters

The cuts on the opposite page show the standard circle form of dials used on various sizes and types of Worthington Meters. The counters for meters of the smaller sizes have a circle registering one cubic foot. This is for testing purposes only, and is to be disregarded in reading the counter.

The counter is read the same as the ordinary gas meter register. The first or right-hand figure of the answer is taken from the circle marked "10;" the second figure from the circle marked "100," and so on. When a pointer is between two figures, the smaller must be taken, as it is obvious that the pointer is traveling towards the larger figure and has not reached it.

Fig. No. 1 shows a six-circle dial, and Fig. No. 2 a seven-circle dial.

Attention is directed to the reading of the pointers as placed, which, with the above explanation, will enable any one to read any counter at a glance.

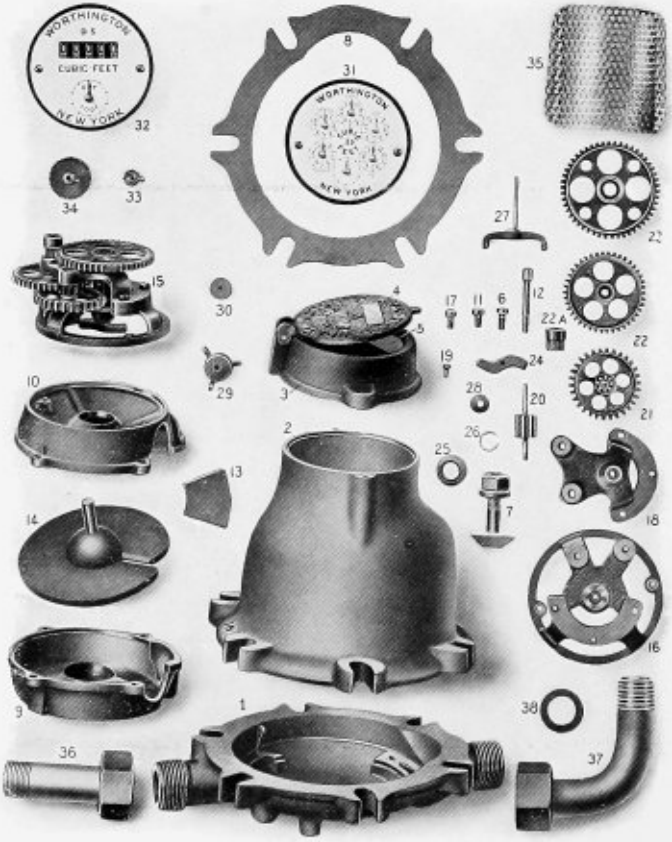
Fig. No. 3 shows a seven-circle dial for meters of larger sizes, without the single cubic foot circle, which is omitted, as it is of no value in testing a large meter.

Fig. No. 4 shows the dial for 4-inch and 6-inch meters. Owing to the increased quantities of water handled by these sizes, the first circle is made to read 100 cubic feet, and consequently the first and second figures are taken from this circle. For instance, if the pointer is between the figures 3 and 4 on the 100 cubic-foot circle, the reading is 30 cubic feet.

When a hand on any circle is so near a figure that it seems to indicate it exactly, look at the circle next lower in denomination, and if the hand on that circle has passed the "0," then the count should be taken for the figure which the hand on the higher circle seems to indicate, but not otherwise.

Dials are also furnished, when required, to register in United States gallons, imperial gallons, litres, etc.

The Worthington Disc Meter



Parts of Model "D" Meter

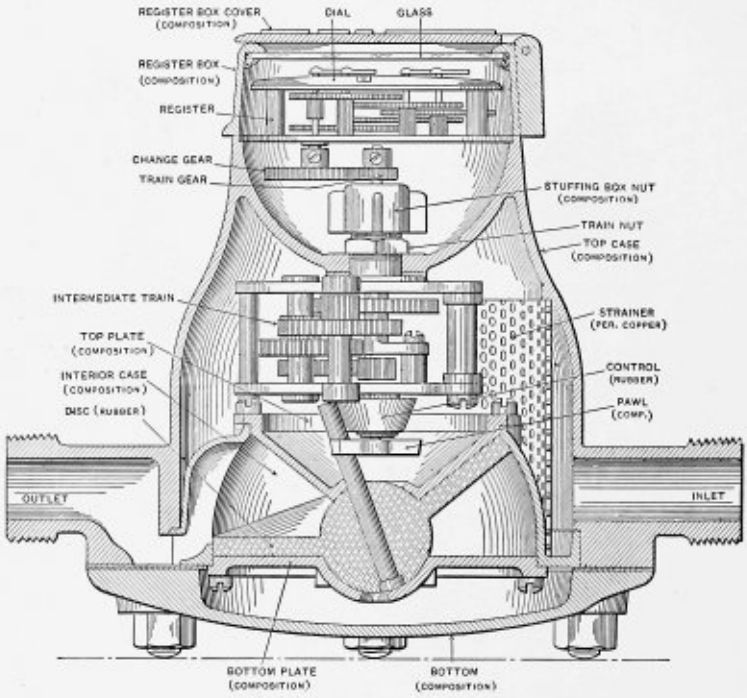
Number and Name of Disc Meter Parts

1 Bottom Case
2 Top Case
3 Register Box
4 Register Box Cover
5 Register Box Glass
6 Register Box Screws
7 Main Case Bolts
8 Main Case Gasket
9 Disc Chamber, Lower Half
10 Disc Chamber, Upper Half
11 Disc Chamber Screws
12 Disc Chamber Holding Screws
13 Disc Chamber Abutment
14 Disc or Piston Complete
15 Intermediate Train Complete
16 Train Bottom Plate
17 Train Bottom Plate Holding Screw
18 Train Center Bearing, Train Top Screw
19 Train Center Bearing Screws
20 Train No. 1 Pinion and Spindle
21 Train No. 1 Gear, Pinion and Spindle
22 Train No. 2 Gear and Spindle
22A Train No. 3 Pinion and Collar
23 Train No. 3 Gear
24 Train Pawl
25 Train Rubber Control
26 Train Rubber Control Split Ring
27 Intermediate Pawl and Spindle
28 Train No. 2 Gear Washer
29 Stuffing Box Nut
30 Cork Packing for Stuffing Box
31 Register complete with Dial (Circular)
32 Register complete with Dial (Straight Reading)
33 Train Gear
34 Change Gear
35 Strainer
36 Straight Coupling, $\frac{3}{8}$-inch to 1-inch
37 90° Bent Coupling, $\frac{3}{8}$-inch to 1-inch
38 Coupling Gasket

NOTE.—In ordering parts, the size and serial number of the meter must be given, in addition to number of part as found in above list.

The Worthington Disc Meter

MODEL C—CURVED DISC TYPE



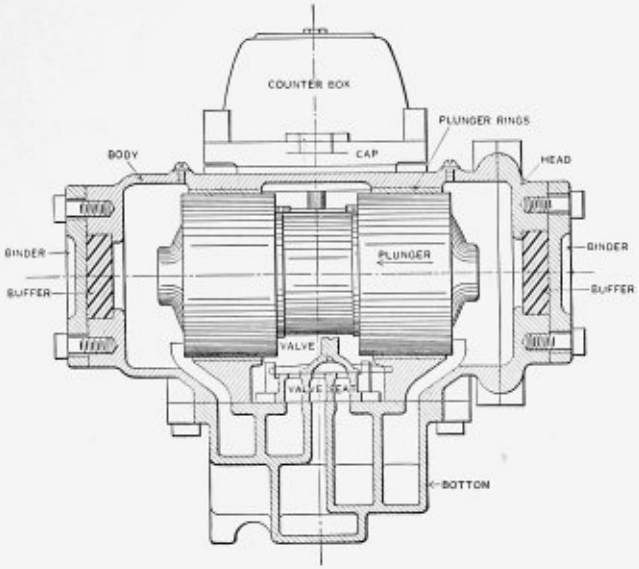
When ordering repairs please state:

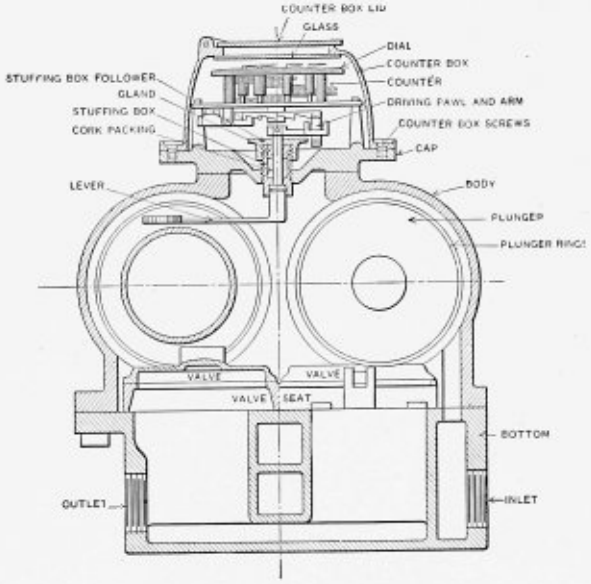
Size and model of meter.

If bottoms are wanted, whether of iron or brass.

If clock and train change gears are wanted, state the number of teeth; this number is stamped on the gear.

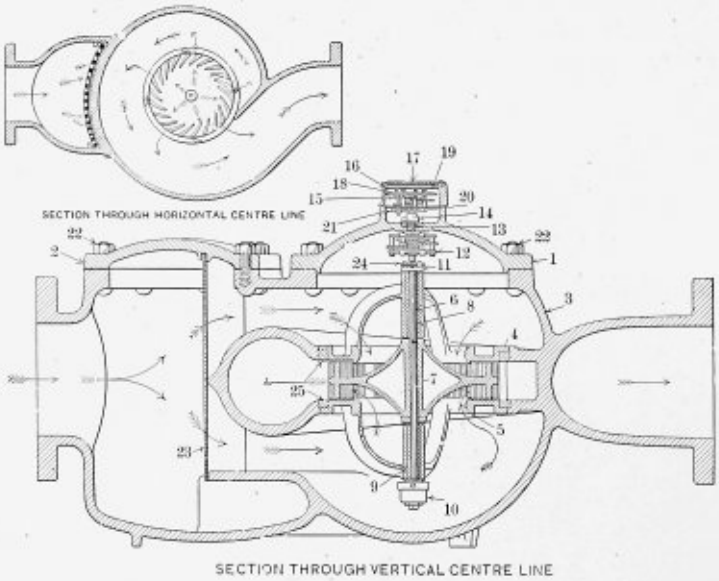
The Worthington Duplex Piston Meter





When ordering repairs, please state size and shop number of meter.

The Worthington Turbine Meter



LIST OF PARTS

No.	Name	No.	Name
1	Main Case Cover	14	Stuffing Box Nut
2	Strainer Cover	15	Register
3	Main Case	16	Register Box
4	Upper Center Bearing	17	Register Cover
5	Lower Center Bearing	18	Dial
6	Center Spindle	19	Glass
7	Turbine Wheel	20	Train Gear
8	Upper Center Bearing Bushing	21	Clock Gear
9	Lower Center Bearing Bushing	22	Stud and Bolt
10	Thrust Bearing Complete	23	Strainer
11	Driving Pawl	24	Gear Train Pawl
12	Gear Train Complete	25	Center Bearing Ring
13	Gear Train Nut		

When ordering repair parts, specify size and shop number of the meter, also as to whether it is for hot or cold water.

Worthington Recording Liquid Weigher

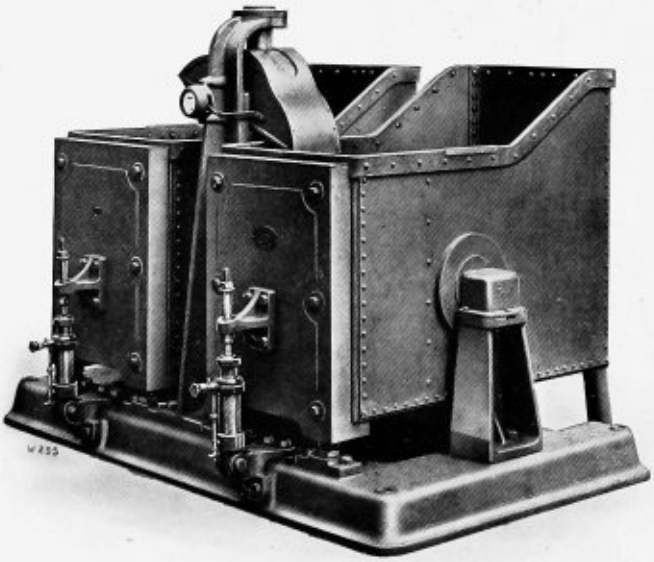
ENCLOSED PATTERN

CAPACITY, 30,000 POUNDS OF WATER PER HOUR

This is the installation recommended for the average power plant where the water handled is very hot. The outer tank takes the place of a hot well, and the storage capacity in the bottom acts as a seal over the suction valves of the boiler feed pump.

Worthington Recording Liquid Weigher

TYPE A—OPEN PATTERN



Worthington Recording Liquid Weigher

This apparatus is designed for measuring liquids by weight, and is to be installed where there is little or no pressure, the liquid flowing into the tanks by gravity. It presents several fields of vital importance in connection with power plant efficiency, and may also be used for many other purposes, such as measuring fuel oil from tanks and tank cars, handling sugar solutions, chemicals or for measuring any material in a liquid state.

It is the only automatic water weighing apparatus made, actually weighing the water against iron weights fastened on the backs of the tanks. It is simple, compact and durable, as well as accurate, overcoming every difficulty heretofore experienced in securing a continuous and accurate record of very hot water used for boiler feeding and other purposes. Obviously it is less expensive than, and is infinitely superior to, any of the awkward and troublesome weighing outfits used in many plants for lack of something better.

It has no bearing and wearing surfaces, no valves to leak, and presents no feature which through friction or wear affords an opportunity for any falling off in the original efficiency; does not depend upon volume, as is the case with every other apparatus manufactured for this purpose, but each tank, the moment it contains a pre-determined weight of liquid, tilts on a frictionless knife-edge bearing, whereupon the whole of its contents is siphoned off without leakage or loss.

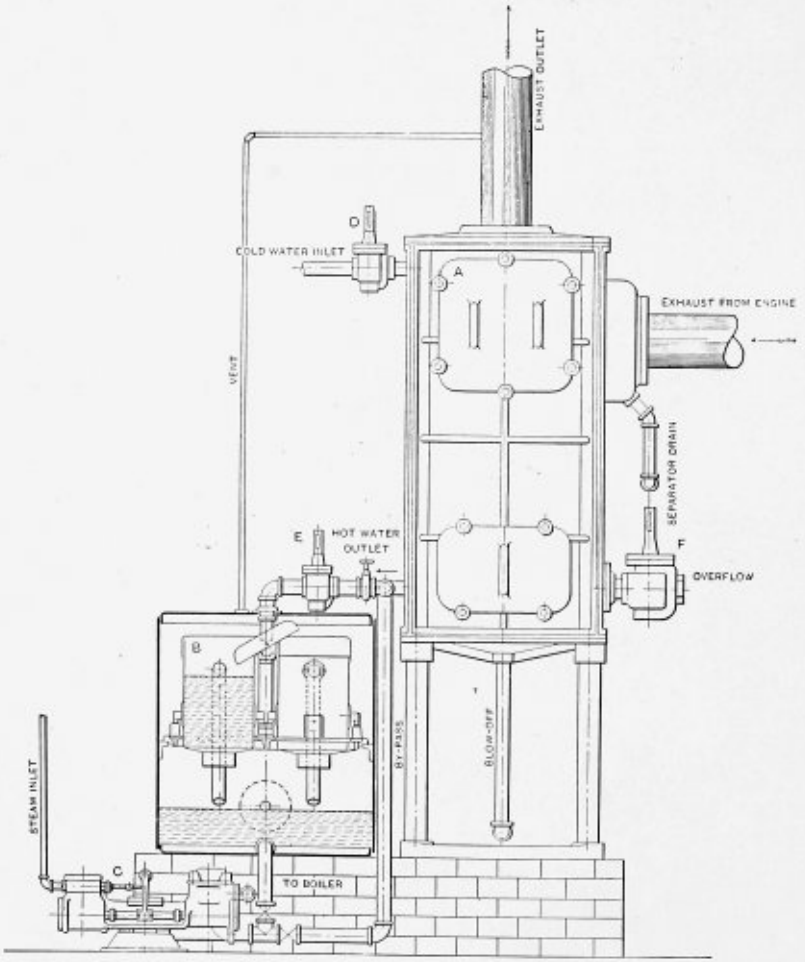
It offers absolute accuracy irrespective of temperature; it is, therefore, the Hot Water Meter which is essential to every up-to-date plant.

It offers practically absolute accuracy irrespective of rate of flow in the type A pattern. It is, therefore, the Hot Water Meter for measuring the returns from coils, heating systems, etc.

It records weight; therefore, the counter reading is final, without making allowances or calculations.

It maintains its original efficiency, on account of absence of wearing surfaces; therefore, the installation is permanent.

When inquiring for weighers, specify maximum actual developed horsepower of the boiler plant or the maximum quantity and character of the liquid to be weighed, the temperature and as to whether a weigher of the open or the enclosed pattern is required. See cuts on pages 33 and 34.



Worthington Recording Liquid Weigher in Combination with Open Feed-Water Heater, Receiving Tank and Boiler-Feed Pump

This represents the ideal installation for a power plant, and, with the continuous record from a water weigher so placed, the highest standard of efficiency of the entire plant must of necessity be maintained.

Useful Information

WATER

A Gallon of Water (U. S. Standard) contains 231 cubic inches and weighs $8\frac{1}{3}$ pounds.

A cubic Foot of Water contains $7\frac{1}{2}$ gallons, or 1728 cubic inches, and weighs $62\frac{1}{2}$ pounds.

A "Miner's Inch" is a measure for the flow of water, and is the amount discharged through an opening 1 inch square in a plank 2 inches in thickness, under a head of 6 inches to the upper edge of the opening; and this is equal to 11.625 U. S. gallons per minute.

The height of a column of fresh water, equal to a pressure of 1 pound per square inch, is 2.31 feet.

A column of water 1 foot high exerts a pressure of .433 pounds per square inch.

The capacity of a cylinder in gallons is equal to the length in inches multiplied by the area in inches, divided by 231 (the cubical contents of one U. S. gallon in inches).

The velocity in feet per minute, necessary to discharge a given volume of water in a given time, is found by multiplying the number of cubic feet of water by 144, and dividing the product by the area of the pipe in inches.

The area of a required pipe, the volume and velocity being given, is found by multiplying the number of cubic feet of water by 144, and dividing the product by the velocity in feet per minute. The area being found, the diameter is obtained by the table of areas.

Doubling the diameter of a pipe increases its capacity four times.

The friction of liquids in pipes increases as the square of the velocity.

The horse-power necessary to elevate water to a given height is found by multiplying the weight of the water elevated per minute, in pounds, by the height in feet, and dividing the product by 33,000.

WEIGHT AND CAPACITY OF DIFFERENT STANDARD GALLONS OF WATER

	Cubic Inches in a Gallon	Weight of a Gallon in Pounds	Gallons in a Cubic Foot	Weight of a Cubic foot of water, English standard, 62.231 lbs. Avoirdupois.
Imperial or English	227.274	10.00	6.232102	
United States.....	231.	8.33111	7.480519	

STEAM

A cubic inch of water, evaporated under ordinary atmospheric pressure, will be converted into, approximately, one cubic foot of steam, and it exerts a mechanical force equal to lifting 2,120 pounds one foot high.

27,222 cubic feet of steam weigh one pound.

13,817 cubic feet of air weigh one pound; the specific gravity of steam atmospheric pressure being .411 that of air at 34 degrees F., and .0006 that of water at the same temperature.

Each nominal horse-power of boilers requires from 4 to 8 gallons of water per hour.

In calculating the horse-power of boilers, allow for tubular boilers 15 square feet, for flue boilers 12 square feet, and for cylinder boilers 10 square feet of heating surface per horse-power.

The unit of power for boilers adopted by the Committee of Judges of the Centennial Exhibition, is as follows: One horse-power equals 30 pounds of water evaporated into dry steam per hour from feed water at 100 degrees F., and under pressure of 70 pounds per square inch above the atmosphere.

One square foot of grate surface will consume from 10 to 12 pounds of hard coal, or from 18 to 20 pounds of soft coal, per hour, natural draft. With forced draft these amounts can be doubled.

Good boilers will evaporate from 7 to 10 pounds of water per hour per pound of coal.

Standard Thicknesses and Weights of Cast Iron Pipes, 12 Feet in Length, Exclusive of Socket

Nominal Diameter of Pipe	Class A		Class B		Class C		Class D		Class E		Class F		Class G		Class H		Class I		Class K	
	Thickness of Shell, Inches	Weight per Length Pounds	Thickness of Shell, Inches	Weight per Length Pounds	Thickness of Shell, Inches	Weight per Length Pounds	Thickness of Shell, Inches	Weight per Length Pounds	Thickness of Shell, Inches	Weight per Length Pounds	Thickness of Shell, Inches	Weight per Length Pounds	Thickness of Shell, Inches	Weight per Length Pounds	Thickness of Shell, Inches	Weight per Length Pounds	Thickness of Shell, Inches	Weight per Length Pounds	Thickness of Shell, Inches	Weight per Length Pounds
4	.34	200	....	.....	.36	215	....	.....	.39	230	....	.....	.42	250	....	.....	.45	265	.48	280
6	.38	330	....	.....	.42	350	....	.....	.46	380	....	.....	.50	420	....	.....	.54	445	....	.....
8	.42	475	....	.....	.48	530	....	.....	.53	575	....	.....	.58	640	....	.....	.63	690	....	.....
10	.47	650	.50	680	.53	720	.56	760	.60	810	.63	.....	.67	890	.70	935	....	.....	....	.....
12	.49	810	.53	855	.57	910	.61	970	.65	1040	.69	1100	.73	1160	.77	1220	....	.....	....	.....
14	.53	1010	.57	1080	.61	1150	.66	1200	.70	1310	.75	1390	.79	1460	.83	1530	....	.....	....	.....
16	.55	1215	.60	1300	.65	1390	.70	1490	.75	1610	.80	1710	.85	1810	.90	1900	....	.....	....	.....
18	.57	1400	.63	1520	.69	1660	.75	1780	.80	1910	.86	2040	....	.....	....	.....	....	.....	....	.....
20	.60	1610	.66	1760	.72	1920	.79	2090	.85	2260	.92	2420	....	.....	....	.....	....	.....	....	.....
24	.64	2050	.72	2290	.80	2550	.88	2780	.95	3000	1.03	3240	....	.....	....	.....	....	.....	....	.....
30	.71	2860	.81	3230	.91	3600	1.01	3950	1.01	4340	1.20	4700	....	.....	....	.....	....	.....	....	.....
36	.79	3800	.90	4270	1.02	4840	1.13	5310	1.25	5900	1.37	6400	....	.....	....	.....	....	.....	....	.....
42	.87	4920	1.00	5560	1.13	6270	1.27	6970	1.40	7720	1.53	8360	....	.....	....	.....	....	.....	....	.....
48	.95	6130	1.10	6970	1.25	7920	1.40	8780	1.55	9740	1.70	10600	....	.....	....	.....	....	.....	....	.....
54	1.03	7510	1.20	8600	1.37	9800	1.54	10900	1.72	12400	1.90	13500	....	.....	....	.....	....	.....	....	.....
60	1.10	8900	1.30	10300	1.50	11900	1.70	13300	1.90	15100	2.10	16500	....	.....	....	.....	....	.....	....	.....

For Testing Meters by Variation in Weight

Per Cent. Variation	One Cubic Foot		Ten Cubic Feet	
	Weight of Trial Quantity when Meter Over-registers	Weight of Trial Quantity when Meter Under-registers	Weight of Trial Quantity when Meter Over-registers	Weight of Trial Quantity when Meter Under-registers
1	61 lbs., 12 ozs.	63 lbs. — ozs.	617 lbs., 7 ozs.	629 lbs., 15 ozs.
1½	61 " 7 "	63 " 5 "	614 " 5 "	633 " 1 "
2	61 " 2 "	63 " 10 "	611 " 3 "	636 " 2 "
2½	60 " 13 "	63 " 15 "	608 " 1 "	639 " 4 "
3	60 " 8 "	64 " 4 "	604 " 15 "	642 " 6 "
3½	60 " 3 "	64 " 9 "	601 " 13 "	645 " 8 "
4	59 " 14 "	64 " 14 "	598 " 12 "	648 " 10 "
4½	59 " 9 "	65 " 3 "	595 " 10 "	651 " 12 "
5	59 " 4 "	65 " 8 "	592 " 8 "	654 " 14 "
5½	58 " 15 "	65 " 13 "	589 " 6 "	658 " — "
6	58 " 10 "	66 " 2 "	586 " 4 "	661 " 2 "
6½	58 " 5 "	66 " 7 "	583 " 2 "	664 " 4 "
7	58 " — "	66 " 12 "	580 " — "	667 " 5 "
7½	57 " 11 "	67 " 1 "	570 " 14 "	670 " 7 "
8	57 " 6 "	67 " 6 "	573 " 13 "	673 " 9 "
8½	57 " 1 "	67 " 11 "	576 " 11 "	676 " 11 "
9	56 " 12 "	68 " — "	567 " 9 "	679 " 13 "
9½	56 " 7 "	68 " 5 "	564 " 7 "	682 " 15 "
10	56 " 2 "	68 " 10 "	561 " 5 "	686 " 1 "

To test meters by variation in weight, place a barrel on a platform scale and draw into it one or ten cubic feet, as indicated by the meter counter. The difference between the weight of the water drawn and the standard weight of one or ten cubic feet is the error in the registration of a meter.

If the trial quantity weighs more, the meter under-registers, and if it weighs less, the meter over-registers.

The above table is for use in connection with tests of meters by variation in weight, and is arranged to show the percentage of variation.

Heat Units in Water Between 32° and 212° F. and Weights of Water per Cubic Foot

Temperature	Heat Units	Weight, Lbs. per Cu. Ft.	Temperature	Heat Units	Weight, Lbs. per Cu. Ft.	Temperature	Heat Units	Weight, Lbs. per Cu. Ft.
32° F.	0.	62.42	123° F.	91.16	61.68	168° F.	136.44	60.81
35	3.	62.42	124	92.17	61.67	169	137.45	60.79
40	8.	62.42	125	93.17	61.65	170	138.45	60.77
45	13.	62.42	126	94.17	61.63	171	139.46	60.75
50	18.	62.41	127	95.18	61.61	172	140.47	60.73
52	20.	62.40	128	96.18	61.60	173	141.48	60.70
54	22.01	62.40	129	97.19	61.58	174	142.49	60.68
56	24.01	62.39	130	98.19	61.56	175	143.50	60.66
58	26.01	62.38	131	99.20	61.54	176	144.51	60.64
60	28.01	62.37	132	100.20	61.52	177	145.52	60.62
62	30.01	62.36	133	101.21	61.51	178	146.52	60.59
64	32.01	62.35	134	102.21	61.49	179	147.53	60.57
66	34.02	62.34	135	103.22	61.47	180	148.54	60.55
68	36.02	62.33	136	104.22	61.45	181	149.55	60.53
70	38.02	62.31	137	105.23	61.43	182	150.56	60.50
72	40.02	62.30	138	106.23	61.41	183	151.57	60.48
74	42.03	62.28	139	107.24	61.39	184	152.58	60.46
76	44.03	62.27	140	108.25	61.37	185	153.59	60.44
78	46.03	62.25	141	109.25	61.36	186	154.60	60.41
80	48.04	62.23	142	110.26	61.34	187	155.61	60.39
82	50.04	61.21	143	111.26	61.32	188	156.62	60.37
84	52.04	62.19	144	112.27	61.30	189	157.63	60.34
86	54.05	62.17	145	113.28	61.28	190	158.64	60.32
88	56.05	62.15	146	114.28	61.26	191	159.65	60.29
90	58.06	62.13	147	115.29	61.24	192	160.67	60.27
92	60.06	62.11	148	116.29	61.22	193	161.68	60.25
94	62.06	62.09	149	117.30	61.20	194	162.69	60.22
96	64.07	62.07	150	118.31	61.18	195	163.70	60.20
98	66.07	62.05	151	119.31	61.16	196	164.71	60.17
100	68.08	62.02	152	120.32	61.14	197	165.72	60.15
102	70.09	62.00	153	121.33	61.12	198	166.73	60.12
104	72.09	61.97	154	122.33	61.10	199	167.74	60.10
106	74.10	61.95	155	123.34	61.08	200	168.75	60.07
108	76.10	61.92	156	124.35	61.06	201	169.77	60.05
110	78.11	61.89	157	125.35	61.04	202	170.78	60.02
112	80.12	61.86	158	126.36	61.02	203	171.79	60.00
114	82.13	61.83	159	127.37	61.00	204	172.80	59.97
115	83.13	61.82	160	128.37	60.98	205	173.81	59.95
116	84.13	61.80	161	129.38	60.96	206	174.83	59.92
117	85.14	61.78	162	130.39	60.94	207	175.84	59.89
118	86.14	61.77	163	131.40	60.92	208	176.85	59.87
119	87.15	61.75	164	132.41	60.90	209	177.86	59.84
120	88.15	61.74	165	133.41	60.87	210	178.87	59.82
121	89.15	61.72	166	134.42	60.85	211	179.89	59.79
122	90.16	61.70	167	135.43	60.83	212	180.90	59.76

Showing U. S. Gallons in Given Number of Cubic Feet

Cubic Feet	Gallons	Cubic Feet	Gallons	Cubic Feet	Gallons
0.1	0.75	50	374.0	9,000	67,324.6
0.2	1.50	60	448.8	10,000	74,805.2
0.3	2.24	70	523.6	20,000	149,610.4
0.4	2.99	80	598.4	30,000	224,415.6
0.5	3.74	90	673.2	40,000	299,220.7
0.6	4.49	100	748.0	50,000	374,025.9
0.7	5.24	200	1,496.1	60,000	448,831.1
0.8	5.98	300	2,244.1	70,000	523,636.3
0.9	6.73	400	2,992.2	80,000	598,441.0
1	7.48	500	3,740.2	90,000	673,246.7
2	14.9	600	4,488.3	100,000	748,051.9
3	22.4	700	5,236.3	200,000	1,496,103.8
4	29.9	800	5,984.4	300,000	2,244,155.7
5	37.4	900	6,732.4	400,000	2,992,207.6
6	44.9	1,000	7,480.0	500,000	3,740,259.5
7	52.4	2,000	14,961.0	600,000	4,488,311.4
8	59.8	3,000	22,441.5	700,000	5,236,363.3
9	67.3	4,000	29,922.0	800,000	5,984,415.2
10	74.8	5,000	37,402.6	900,000	6,732,467.1
20	149.6	6,000	44,883.1	1,000,000	7,480,519.0
30	224.4	7,000	52,363.6		
40	299.2	8,000	59,844.1		

From the above any cubic feet reading may readily be converted into U. S. gallons as follows:

How many gallons are represented by 53,928 cubic feet.

50,000 cubic feet = 374,025.9 gallons,
3,000 " = 22,441.5 "
900 " = 6,732.4 "
20 " = 149.6 "
8 " = 59.8 "

53,928 cubic feet = 403,409.2 gallons.

Loss by Friction of Water in Pipes

This table shows the loss in pounds pressure per square inch for each 100 feet in length due to friction when discharging the given quantities of water per minute.

Gals. per Min.	SIZES OF PIPES—INSIDE DIAMETER														
	¾ inch	1 inch	1¼ inch	1½ inch	2 inch	2½ inch	3 inch	4 inch	6 inch	8 inch	10 inch	12 inch	14 inch	16 inch	18 inch
5	3.3	0.84	0.31	0.12											
10	13.0	3.16	1.05	0.47	0.12										
15	28.7	6.98	2.38	0.97											
20	50.4	12.3	4.07	1.66	0.42										
25	78.0	19.0	6.40	2.62		0.21	0.10								
30		27.5	9.15	3.75	0.91										
35		37.0	12.4	5.05											
40		48.0	16.1	6.52	1.60										
45			20.2	8.15											
50			24.9	10.0	2.44	0.81	0.35	0.09							
75			56.1	22.4	5.32	1.80	0.74								
100				39.0	9.46	3.20	1.31	0.33	0.05						
125					14.9	4.89	1.99								
150					21.2	7.0	2.85	0.69	1.10						
175					28.1	9.46	3.85								
200					37.5	12.47	5.02	1.22	0.17						
250						19.66	7.76	1.89	0.26	0.07	0.03	0.01			
300						28.06	11.2	2.66	0.37	0.09	0.04				
350							15.2	3.65	0.50	0.12	0.05	0.02			
400							19.5	4.73	0.65	0.16	0.06				
450							25.0	6.01	0.81	0.20	0.07	0.03			
500							30.8	7.43	0.96	0.25	0.09	0.04	0.017	0.009	0.005
750									2.21	0.53	0.18	0.08			
1000									3.88	0.94	0.32	0.13	0.062	0.036	0.020
1250										1.46	0.49	0.20			
1500										2.09	0.70	0.29	0.135	0.071	0.040
1750											0.95	0.38			
2000											1.23	0.49	0.234	0.123	0.071
2250												0.63			
2500												0.77	0.362	0.188	0.107
3000												1.11	0.515	0.267	0.150
3500													0.697	0.365	0.204
4000													0.910	0.472	0.263
4500														0.593	0.333
5000														0.730	0.408

Showing How City Water May Be Wasted

Gallons Discharged per Minute Through Various Sized Orifices Under Stated Pressure

Head		Velocity of Discharge in Feet per Second	DIAMETERS IN INCHES									
Lbs.	Feet		1/16	1/8	1/4	1/2	3/4	1	1 1/4	1 1/2	1 3/4	2
10	23.1	38.58	.37	1.48	5.90	23.6	53.2	94.4	148	212	289	378
15	34.7	47.25	.45	1.81	7.23	28.7	65.1	116	181	260	354	463
20	46.2	54.55	.52	2.09	8.35	33.4	75.3	134	209	300	409	354
25	57.8	60.99	.58	2.33	9.33	37.2	84.1	149	233	336	457	597
30	69.3	66.82	.64	2.56	10.2	40.9	92.2	164	256	368	501	654
35	80.9	72.16	.69	2.76	11.0	44.2	99.6	177	276	397	541	707
40	92.4	77.14	.74	2.95	11.8	47.2	106	189	295	425	578	755
45	104.0	81.83	.78	3.13	12.5	50.2	113	200	313	450	613	801
50	115.5	86.26	.82	3.30	13.2	52.8	119	211	330	475	646	845
55	127.1	90.46	.86	3.46	13.8	55.4	125	221	346	498	678	886
60	138.6	94.49	.90	3.62	14.5	57.8	130	231	362	520	708	925
65	150.2	98.35	.94	3.77	15.1	60.2	136	241	377	542	737	963
70	161.7	102.06	.97	3.91	15.6	62.5	141	250	391	562	765	999
75	173.3	105.65	1.01	4.04	16.2	64.6	146	259	404	582	792	1034
80	184.8	109.11	1.04	4.18	16.7	66.6	150	267	418	601	818	1068
85	196.4	112.46	1.07	4.31	17.2	68.8	155	275	431	620	843	1101
90	207.9	115.72	1.10	4.43	17.7	70.8	160	283	443	637	867	1133
95	219.5	118.89	1.13	4.55	18.2	72.8	164	291	455	655	891	1164
100	231.1	121.98	1.16	4.67	18.7	74.6	168	299	467	672	914	1194
105	242.6	125.00	1.19	4.78	19.1	76.5	172	306	478	688	937	1224
110	254.2	127.94	1.22	4.90	19.6	78.3	177	313	490	705	959	1253
115	265.7	130.82	1.25	5.01	20.0	80.1	181	320	501	720	980	1281
120	277.3	133.63	1.27	5.12	20.4	81.8	184	327	512	736	1001	1308
125	288.8	136.38	1.30	5.22	20.9	83.5	188	334	522	751	1022	1335
130	300.4	139.08	1.33	5.32	21.3	85.1	192	341	532	766	1042	1362

All pressure is taken at the orifice, no allowance being made for friction in the pipe. In practical calculations the head consumed by the friction of the water flowing from the source to the orifice must be considered. If the water is flowing through a nozzle, about 64 per cent. of the above capacities may be considered as the actual discharge for a ring nozzle and about 82 per cent. for a good form of tapering smooth nozzle.

Under 100 pounds pressure a leak the size of the lead in a pencil would pass 1,500 gallons of water per day. This quantity would supply three families, and represents a loss to the water works, at the average charge for water, of over one hundred dollars per year. No water department can afford to leave a single tap unmetered.

Showing Cost of Water at Stated Rates per 1,000 Gallons

Number of Cubic Feet	Cost per 1,000 Gallons							
	5 Cents	6 Cents	8 Cents	10 Cents	15 Cents	20 Cents	25 Cents	30 Cents
20	$0.007	$0.009	$0.012	$0.015	$0.021	$0.030	$0.037	$0.045
40	0.015	0.018	0.024	0.030	0.045	0.060	0.075	0.090
60	0.022	0.027	0.036	0.045	0.066	0.090	0.112	0.135
80	0.030	0.036	0.048	0.060	0.090	0.120	0.150	0.180
100	0.037	0.049	0.060	0.075	0.111	0.150	0.187	0.224
200	0.075	0.030	0.120	0.150	0.225	0.299	0.374	0.449
300	0.112	0.135	0.180	0.224	0.336	0.449	0.561	0.673
400	0.150	0.180	0.239	0.299	0.450	0.598	0.748	0.898
500	0.188	0.224	0.299	0.374	0.564	0.748	0.935	1.122
600	0.224	0.269	0.359	0.449	0.674	0.898	1.122	1.346
700	0.262	0.314	0.419	0.524	0.786	1.047	1.309	1.571
800	0.299	0.350	0.479	0.598	0.897	1.197	1.496	1.795
900	0.337	0.404	0.539	0.673	1.011	1.346	1.683	2.020
1,000	0.374	0.449	0.598	0.748	1.122	1.496	1.870	2.244
2,000	0.748	0.898	1.197	1.496	2.244	2.992	3,740	4.488
3,000	1.122	1.346	1.795	2.244	3.366	4.488	5.610	6.732
4,000	1.496	1.795	2.393	2.992	4.488	5.984	7.480	8.976
5,000	1.870	2.244	2.992	3.740	5.610	7.480	9.350	11.220
6,000	2.244	2.692	3.590	4.488	6.732	8.976	11.220	13.464
7,000	2.618	3.141	4.189	5.236	7.854	10.472	13.090	15.708
8,000	2.992	3.590	4.787	5.984	8.976	11.968	14.961	17.953
9,000	3.366	4.039	5.385	6.732	10.098	13.464	16.831	20.197
10,000	3.74	4.488	5.984	7.480	11.122	14.961	18.701	22.441
20,000	7.48	8.976	11.968	14.961	22.443	29.992	37.402	44.882
30,000	11.22	13.46	17.95	22.44	33.644	44.88	56.10	67.32
40,000	14.96	17.95	23.94	29.92	44.885	59.84	74.80	89.77
50,000	18.70	22.44	29.92	37.40	56.103	74.80	93.50	112.20
60,000	22.44	26.92	35.90	44.88	67.323	89.76	112.20	134.64
70,000	26.18	31.41	41.89	52.36	78.543	104.72	130.90	157.08
80,000	29.92	35.90	47.87	59.84	89.766	119.68	149.61	179.53
90,000	33.66	40.39	53.85	67.32	100.986	134.64	168.31	201.97
100,000	37.40	44.88	59.84	74.80	111.22	149.61	187.01	224.41
200,000	74.81	89.76	119.68	149.61	224.43	299.22	374.02	448.82
300,000	112.20	134.64	179.53	224.41	336.64	448.83	561.03	673.24
400,000	149.61	179.53	239.37	299.22	448.85	598.44	748.05	897.66
500,000	187.01	224.41	299.22	374.02	561.03	748.05	935.06	1122.07
600,000	224.41	269.29	359.06	448.83	673.23	897.66	1122.07	1346.49
700,000	261.81	314.18	418.90	523.63	785.43	1047.27	1309.08	1570.88
800,000	299.22	359.06	478.75	598.44	897.66	1196.88	1496.10	1795.32
900,000	336.62	403.94	538.59	673.24	1009.86	1346.49	1683.11	2019.73
1,000,000	374.02	448.83	598 44	748.05	1122.06	1498.10	1870.12	2244.15

Contents in Cubic Feet and U. S. Gallons

(From Trautwein)

Of 231 cubic inches (or 7.4805 gallons to a cubic foot); and for one foot of length of the cylinder. For the contents for a greater diameter than any in the table take the quantity opposite one-half said diameter and multiply it by 4. Thus, the number of cubic feet in one foot length of a pipe 80 inches in diameter is equal to $8.728 \times 4 = 34.912$ cubic feet. So also with gallons and areas.

Diameter in Inches	Diam. in Decimals of a Foot	For 1 Foot in Length: Cubic Ft.; Also Area in Sq. Ft.	For 1 Foot in Length: Gallons of 231 Cub. Ins.
1/16	.0208	.0003	.0026
5–16	.0260	.0005	.0040
3/8	.0313	.0008	.0057
7–16	.0365	.0010	.0078
1/2	.0417	.0014	.0102
9–16	.0469	.0017	.0129
5/8	.0521	.0021	.0159
11–16	.0573	.0026	.0193
3/4	.0625	.0031	.0230
13–16	.0677	.0036	.0270
7/8	.0729	.0042	.0312
15–16	.0781	.0048	.0359
1.	.0833	.0055	.0408
1 1/16	.1042	.0085	.0638
1 1/8	.1250	.0123	.0918
1 3/16	.1458	.0168	.1250
2.	.1667	.0218	.1632
1 5/16	.1875	.0276	.2066
1 3/8	.2083	.0341	.2550
1 7/16	.2292	.0413	.3085
3.	.2500	.0491	.3673
1 9/16	.2708	.0576	.4310
1 5/8	.2917	.0668	.4998
1 11/16	.3125	.0767	.5738
4.	.3333	.0873	.6528
1 13/16	.3542	.0985	.7370
1 7/8	.3750	.1105	.8263
1 15/16	.3958	.1231	.9205
5.	.4167	.1364	1.020
2 1/16	.4375	.1503	1.124
2 1/8	.4583	.1650	1.234
2 3/16	.4792	.1803	1.349
6.	.5000	.1963	1.469
2 5/16	.5208	.2130	1.594
2 3/8	.5417	.2305	1.724
2 7/16	.5625	.2485	1.859
7.	.5833	.2673	1.999
2 9/16	.6042	.2868	2.144
2 5/8	.6250	.3068	2.295
2 11/16	.6458	.3275	2.450
8.	.6667	.3490	2.611
2 13/16	.6875	.3713	2.777
2 7/8	.7083	.3940	2.948
2 15/16	.7292	.4175	3.125
9.	.7500	.4418	3.305
3 1/16	.7708	.4668	3.492
3 1/8	.7917	.4923	3.682
3 3/16	.8125	.5185	3.879
10.	.8333	.5455	4.081
3 5/16	.8542	.5730	4.286
3 3/8	.8750	.6013	4.490
3 7/16	.8958	.6303	4.714
11.	.9167	.6600	4.937
3 9/16	.9375	.6903	5.163
3 5/8	.9583	.7213	5.395
3 11/16	.9792	.7530	5.633
12.	1 Foot	.7854	5.876
1/2	1.042	.8523	6.375
13.	1.083	.9218	6.895
1/2	1.125	.9940	7.435
14.	1.167	1.069	7.997
1/2	1.208	1.147	8.578
15.	1.250	1.227	9.180
1/2	1.292	1.310	9.801
16.	1.333	1.396	10.44
1/2	1.375	1.485	11.11
17.	1.417	1.576	11.79
1/2	1.458	1.670	12.50
18.	1.500	1.767	13.22
1/2	1.542	1.867	13.97
19.	1.583	1.969	14.73
1/2	1.625	2.074	15.52
20.	1.666	2.182	16.32
1/2	1.708	2.292	17.15
21.	1.750	2.405	17.99
1/2	1.792	2.521	18.86
22.	1.833	2.640	19.75
1/2	1.875	2.761	20.65
23.	1.917	2.885	22.58
1/2	1.958	3.012	21.53
24.	2.000	3.142	23.50
25.	2.083	3.409	25.50
26.	2.166	3.687	27.58
27.	2.250	3.976	29.74
28.	2.333	4.276	31.99
29.	2.416	4.587	34.31
30.	2.500	4.909	36.72
31.	2.583	5.241	39.21
32.	2.666	5.585	41.78
33.	2.750	5.940	44.43
34.	2.833	6.305	41.17
35.	2.916	6.681	49.98
36.	3.000	7.069	52.88
37.	3.083	7.468	55.86
38.	3.166	7.867	58.92
39.	3.350	8.296	62.06
40.	3.333	8.728	65.29
41.	3.416	9.168	68.58
42.	3.500	9.620	71.96
43.	3.583	10.084	75.43
44.	3.666	10.560	79.00
45.	3.075	11.044	82.62
46.	3.833	11.540	86.32
47.	3.916	12.048	90.12
48.	4.000	12.566	94.02

Pressure of Water

The pressure of water in pounds per square inch for every foot in height to 300 feet; and then by intervals to 1,000 feet head. By this table, from the pounds pressure per square inch, the feet head is readily obtained; and *vice versa*.

Feet Head	Pressure per Sq. Inch	Feet Head	Pressure per Sq. Inch	Feet Head	Pressure per Sq. Inch	Feet Head	Pressure per Sq. Inch	Feet Head	Pressure per Sq. Inch
1	0.43	33	14.29	65	28.15	97	42.01	129	55.88
2	0.86	34	14.72	66	28.58	98	42.45	130	56.31
3	1.30	35	15.16	67	29.02	99	42.88	131	56.74
4	1 73	36	15.59	68	29.45	100	43.31	132	57.18
5	2.16	37	16.02	69	29.88	101	43.75	133	57.61
6	2.59	38	16.45	70	30.32	102	44.18	134	58.04
7	3.03	39	16.89	71	30.75	103	44.61	135	58.48
8	3.46	40	17.32	72	31.18	104	45.05	136	58.91
9	3.89	41	17.75	73	31.62	105	45.48	137	59.34
10	4.33	42	18.19	74	32.05	106	45.91	138	59.77
11	4.76	43	18.62	75	32.48	107	46.34	139	60.21
12	5.20	44	19.05	76	32.92	108	46.78	140	60.64
13	5.63	45	19.49	77	33.35	109	47.21	141	61.07
14	6.06	46	19.92	78	33.78	110	47.64	142	61.51
15	6.49	47	20.35	79	34.21	111	48.08	143	61.94
16	6.93	48	20.79	80	34.65	112	48.51	144	62.37
17	7.36	49	21.22	81	35.08	113	48.94	145	62.81
18	7.79	50	21.65	82	35.52	114	49.38	146	63.24
19	8.22	51	22.09	83	35.95	115	49.81	147	63.67
20	8.66	52	22.52	84	36.39	116	50.24	148	64.10
21	9.09	53	22.95	85	36.82	117	50.68	149	64.54
22	9.53	54	23.39	86	37.25	118	51.11	150	64.97
23	9.96	55	23.82	87	37.68	119	51.54	151	65.40
24	10.39	56	24.26	88	38.12	120	51.98	152	65.84
25	10.82	57	24.69	89	38.55	121	52.41	153	66.27
26	11.26	58	25.12	90	38.98	122	52.84	154	66.70
27	11.69	59	25.55	91	39.42	123	53.28	155	67.14
28	12.12	60	25.99	92	39.85	124	53.71	156	67.57
29	12.55	61	26.42	93	40.28	125	54.15	157	68.00
30	12.99	62	26.85	94	40.72	126	54.58	158	68.43
31	13.42	63	27.29	95	41.15	127	55.01	159	68.87
32	13.86	64	27.72	96	41.58	128	55.44	160	69.31

Pressure of Water—Continued

The pressure of water in pounds per square inch for every foot in height to 300 feet; and then by intervals, to 1000 feet head. By this table, from the pounds per square inch, the feet head is readily obtained; and *vice versa*.

Feet Head	Pressure per Sq. Inch	Feet Head	Pressure per Sq. Inch	Feet Head	Pressure per Sq. Inch	Feet Head	Pressure per Sq. Inch	Feet Head	Pressure per Sq. Inch
161	69.24	193	83.60	225	97.46	257	111.32	289	125.18
162	70.17	194	84.03	226	97.90	258	111.76	290	125.62
163	70.61	195	84.47	227	98.33	259	112.19	291	126.05
164	71.04	196	84.90	228	98.76	260	112.62	292	126.48
165	71.47	197	85.33	229	99.20	261	113.06	293	126.92
166	71.91	198	85.76	230	99.63	262	113.49	294	127.35
167	72.34	199	86.20	231	100.06	263	113.92	295	127.78
168	72.77	200	86.63	232	100.49	264	114.36	296	128.22
169	73.20	201	87.07	233	100.93	265	114.79	297	128.65
170	73.64	202	87.50	234	101.36	266	115.22	298	129.08
171	74.07	203	87.93	235	101.79	267	115.66	299	129.51
172	74.50	204	88.36	236	102.23	268	116.09	300	129.95
173	74.94	205	88.80	237	102.60	269	116.52	310	134.28
174	75.37	206	89.23	238	103.09	270	116.96	320	138.62
175	75.80	207	89.66	239	103.53	271	117.39	330	142.95
176	76.23	208	90.10	240	103.96	272	117.82	340	147.28
177	76.67	209	90.53	241	104.39	273	118.26	350	151.61
178	77.10	210	90.96	242	104.83	274	118.69	360	155.94
179	77.53	211	91.39	243	105.26	275	119.12	370	160.27
180	77.97	212	91.83	244	105.69	276	119.56	380	164.61
181	78.40	213	92.26	245	106.13	277	119.99	390	168.94
182	78.84	214	92.69	246	106.56	278	120.42	400	173.27
183	79.27	215	93.13	247	106.99	279	120.85	500	216.58
184	79.70	216	93.56	248	107.43	280	121.29	600	259.90
185	80.14	217	93.99	249	107.86	281	121.72	700	303.22
186	80.57	218	94.43	250	108.29	282	122.15	800	346.54
187	81.00	219	94.86	251	108.73	283	122.59	900	389.86
188	81.43	220	95.30	252	109.16	284	123.02	1000	433.18
189	81.87	221	95.73	253	109.59	285	123.45		
190	82.30	222	96.16	254	110.03	286	123.89		
191	82.73	223	96.60	255	110.46	287	124.32		
192	83.17	224	97.03	256	110.89	288	124.75		

Index

	PAGE
Beer Meter—Disc Pattern	21
Beer Meter—Duplex Piston Pattern	20
Counter Box	6
Disc Meter—General Description	5
Disc Meter—List of Sizes	7
Disc Meter—Sectional Cut	4
Elevated Counter	25
Fish Trap	19
Frost-Proof Meter	11
Heater and Weigher Installation	36
Hot Water Meter—By-Pass Fittings	15
Hot Water Meter—Duplex Piston Pattern	14
Hot Water Meter—Installation and Care	18
Hot Water Meter—List of Sizes	17
Hot Water Meter—Turbine Pattern	16
Intermediate Train—Disc Meter	6
Oil Meter—Duplex Piston Pattern	22
Oil Meter—Installation and Calibration	23
Parts—Disc Meter, Model "C"	30
Parts—Disc Meter, Model "D"	28
Parts—Duplex Piston Meter	31
Parts—Turbine Meter	32
Piston Meter, Duplex—General Description	8
Piston Meter—List of Sizes	9
Reading the Counter	27
Recording Liquid Weigher—Enclosed Pattern	33
Recording Liquid Weigher—General Description	35
Recording Liquid Weigher—Open Pattern, Type "A"	34
Straight Reading Counter	26
Strainer—Heavy Pattern	18
Strainer—Standard	19
Testing Water Meters	24
Turbine Meter—General Description	12
Turbine Meter—List of Sizes	13
Waste of Water	43
Useful Information	37

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