DEN STAVE PIPE

BUILT BY

REDWOOD MANUFACTURERS CO.

SUCCESSORS TO

EXCELSIOR WOODEN PIPE CO.

SHIRLEY BAKER
MANAGER

OFFICE
916 BALBOA BUILDING
SAN FRANCISCO, CAL.
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PREFACE.

THIS BOOK is intended to furnish general information regarding the construction, the advantages and the use of our wooden stave pipe. See Transactions of American Society of Civil Engineers, Vol. XLI, Stave Pipe—Its Economic Design and Economy of Its Use, by Arthur L. Adams, M. Am. Soc. C. E.

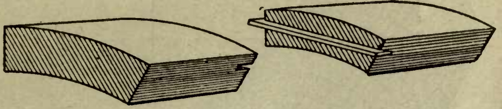
Quotations will be promptly furnished upon request.

Tables of carrying capacity of stave pipe are appended, which we hope may be of value to engineers. They are especially prepared for this book and should be used with such restrictions as are set forth in their preface.

DESCRIPTION OF PIPE

The pipe is composed of wooden staves, banded with steel hoops.

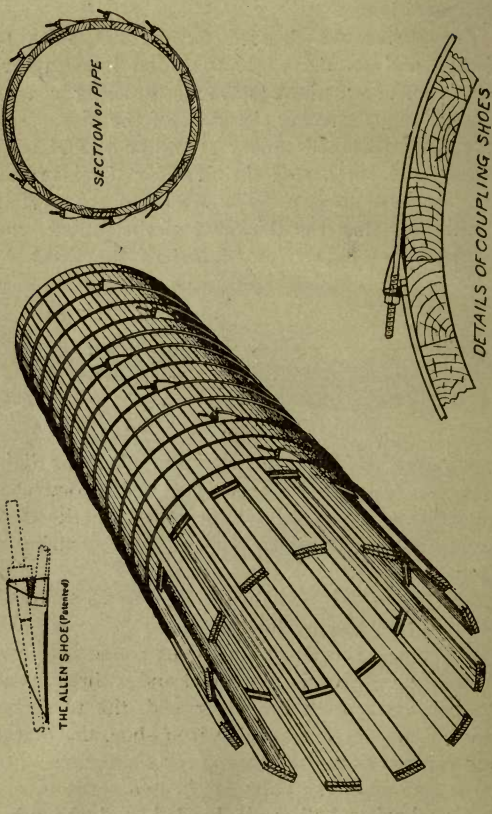
The staves are dressed on the flat sides to circles, and on the edges to radial lines, a certain number of these staves completing a true circular ring, forming the shell of the pipe. The staves are trimmed square at the ends, and have a saw kerf cut across the face for the insertion of a metallic tongue. The width of the kerf is a little less than the thickness of the tongue, and its depth is slightly less than half the width of



the tongue, which is driven into place by light taps of a hammer. The tongue is cut somewhat longer than the width of the stave and its ends penetrate the adjoining staves, thus securing a tight butt joint.

The staves are built in the pipe so as to break joint at least twenty-four inches.

The hoops consist of steel bolts round in cross-section with a head at one end and a thread with washer and nut at the other end, the two ends being united by a malleable iron shoe, the thread and nut providing the means for tightening. For large size pipes the bolts are in two sections, one section having both ends headed, and the other both ends threaded. In this case two malleable iron shoes are required for a complete band.


SECTION OF PIPE
DETAILS OF COUPLING SHOES
THE ALLEN SHOE (Patented)

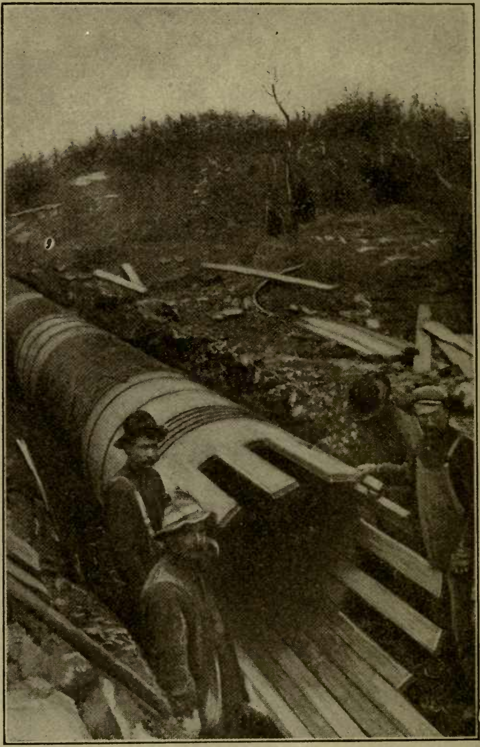
The shoe is so shaped that it fits closely upon the outside of the pipe and that the strain of the rod produces a straight pull, the entire band when in place lying in a plane perpendicular to the direction of pipe.

The threads on the rods are cold pressed or upset and the dimensions of the head, thread, nut and shoe are such that the connection of the rod ends is the strongest part of the hoop.

When the bands are spaced for high pressure the power of the numerous nuts turned up at even moderate tension is sufficient to crush the wood and collapse it, if carelessly exerted. The effect of this construction, when the bands are at proper tension, is to produce a stiff, hollow beam of wood of great strength, and which for rigidity against flattening is only equaled by cast-iron pipe.

MATERIALS

The wood used for pipe staves should be sound and clear, free from knots, shakes, pitch seams and other imperfections. It should be strong enough to resist crushing under a firm tensile strain on the bands and should not become spongy when saturated. It should not shrink or swell excessively. The finished stave should be smooth and close grained to resist percolation within the limits of pressure for wood pipe. California redwood possesses all of these requisite properties. Pine, spruce and fir are being used successfully in the manufacture of pipe staves, but it is well known that the California redwood under all conditions when built into pipe has a



Erection of 48-Inch Pipe

longer life than any other lumber now being used for this purpose.

The staves are dressed, trimmed and slotted with accuracy, are shipped in box-cars, and from beginning to end are handled with the greatest care.

Bolts.—The bolts are made of mild steel, generally having a tensile strength of from 58,000 to 65,000 pounds per square inch. Both the rod steel and the finished bolts are subjected to careful tests before leaving the mill. They are shipped straight, tied in bundles and are bent upon arrival and coated with paint or dipped in hot asphaltum.

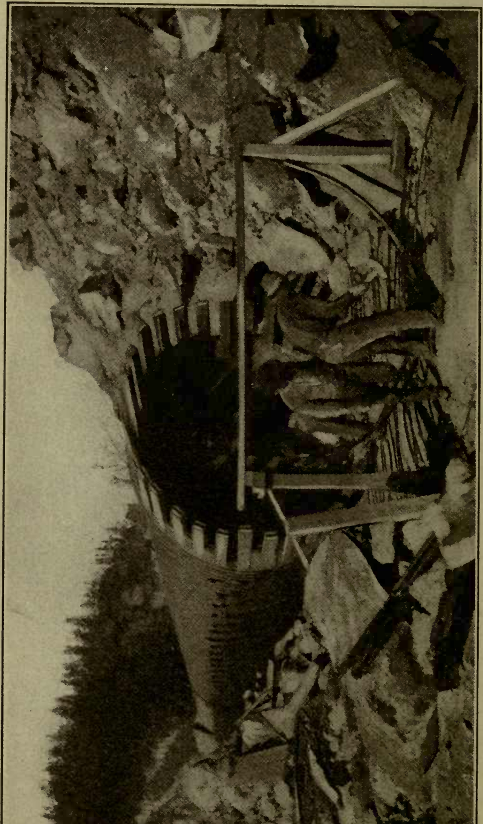
Shoes.—The shoes are made of the best quality of malleable iron, free from sharp edges, splints, tags and blow holes. They are coated with paint or asphaltum, the same as the bands.

Clips.—The clips, or concealed metallic tongues, are sometimes shipped ready cut and boxed, or they are shipped as band iron in bundles and cut on the work. They are one and a half inches wide and No. 14, No. 12 or No. 10 B. W. G. iron, according to the size of the pipe.

BANDING

The bands around the pipe serve the purpose of preserving the shape of the pipe and preventing its collapse from suddenly reduced pressures or from weight of back-filled material, and of preventing the pipe from leaking and bursting when under pressure.

To this end they should be designed so as to offer the required resistance to all strains and they should be proportioned as regards their dia-



Erection of 9-Foot Pipe

meter, number and bearing surface upon the wood so as to afford sufficiently frequent supports to the staves to avoid objectionable deflection between bands and to prevent indentation.

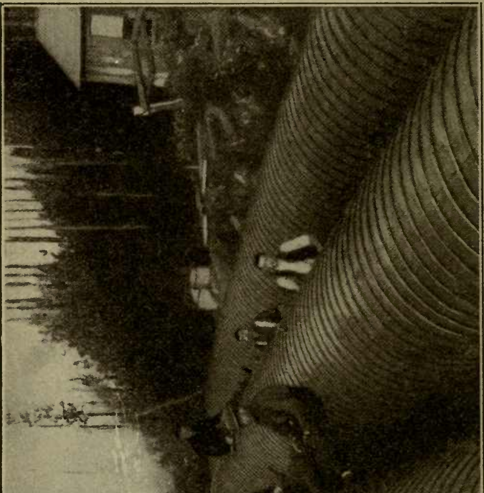
The possible strains upon a pipe band are complex in their nature, depending upon water pressure, initial strain, swelling power of the wood, superincumbent load, water hammer, etc., and considerable experience and judgment are required to determine intelligently the allowance to be made for strains additional to those caused by mere water pressure.

CONSTRUCTION

The method of construction is sufficiently illustrated in the accompanying cuts. It may be properly observed here, as is well known to practical pipe men, that to confine water under pressure and produce tight work requires experience as well as conscientious care in construction, no matter how well the parts may be designed and how simple a matter the work of assembling the parts may seem to be. The more ignorant a contractor, the more readily will he undertake a piece of work of this kind to his own detriment and the serious annoyance and loss of the owner.

LIMITS OF PRESSURE

The seam joints of a stave pipe are tight when the staves are pressed together with a pressure per square inch exceeding the water pressure. The softness of saturated staves fixes the limit of pressures under which the stave pipe can be kept tight, and for constructive reasons the work-

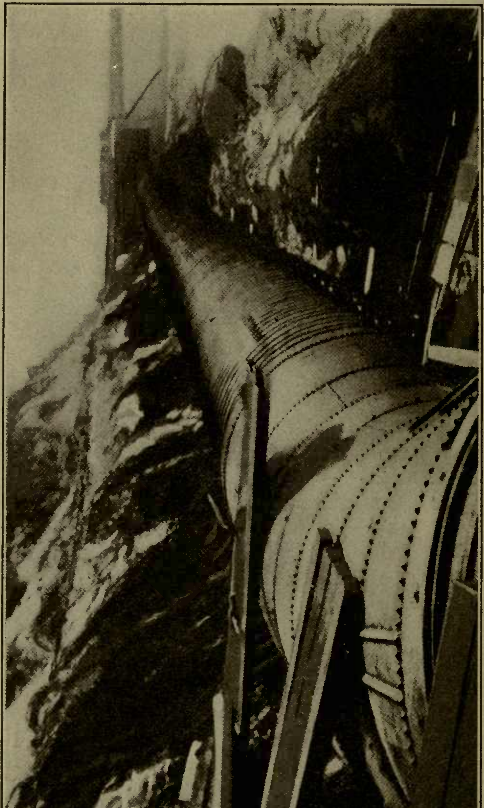


Three Lines of 54-Inch Pipe, Showing Compound Curves ing pressure to which stave pipe is subjected should be well within the limit so determined. Experience has shown that 200 feet is a safe and practical limit to which stave pipe can be built.

DURABILITY

The fact that wood, where in frequent intermittent contact with water, is observed to rot fast is no evidence that it does so when continually submerged. When sound wood is kept thoroughly wet it does not rot. Hundreds of important stone structures depend for their stability and support on wooden piles; and when the precaution was taken to use none but good material, and to keep it below low water level, no decay has resulted. These structures have stood the test of time, some of them for many centuries, and where parts have been removed, and old piles taken up, they have been found to be sound. Wooden bored water pipes of small diameter have been largely used in England and in some of our Eastern cities, and when dug up, after many years of continuous service, have been found as sound and clean as when they were put in.

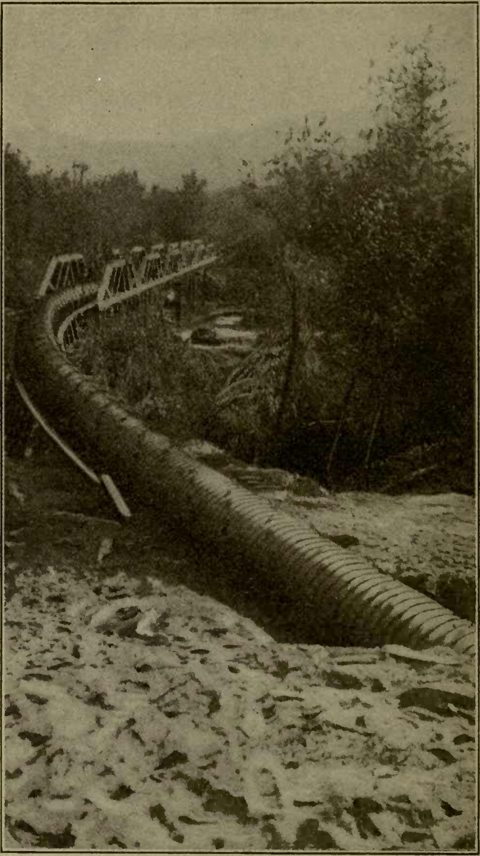
The essential condition to insure an indefinite life of the wooden staves, is that they must be kept constantly saturated. This can best be attained by burying the pipe in the ground, as thereby all evaporation from the surface of the pipe will be prevented. If so buried, it is necessary that the pipe should run full at intervals of sufficiently long duration to cause and maintain complete saturation of the wood. When the



9-Foot Pipe, Showing Riveted Steel Elbow Connected to Wooden Pipe by Means of a Lead Joint staves are once thoroughly soaked they will remain so for an indefinite time if the pipe is buried and there be no ventilation through the pipe.

If it be admitted that the life of the staves, supposing the above condition to have been complied with, is indefinitely long, the life of the pipe as a whole is dependent upon that of the metal bands. In cast, wrought iron or steel pipe the metal serves the double purpose of forming the water-tight shell and providing the strength to resist water pressure. If the metal through corrosion fails in either purpose, the pipe has become useless. It is a notable fact that iron pipe never fails because of reduction in strength, but always because of a pitting action which affords numerous passages for the water, causing leaks. This happens in riveted pipe long before corrosion has seriously weakened the strength of the metal, and such pipe would have a very much longer usefulness could its life be extended until the metal had actually become too weak to resist the strains from water pressure. Such increased life is secured to stave pipe because the metal is placed upon the pipe for purposes of strength only; and while steel pipe often has to be abandoned when but 5% of its strength is destroyed by corrosion, stave pipe would continue tight and the bands would not be strained beyond their elastic limit until 60% of the metal is rusted away.

The shape in which the metal placed on the stave pipe is employed, being of round section, is moreover far more favorable to resist corrosive

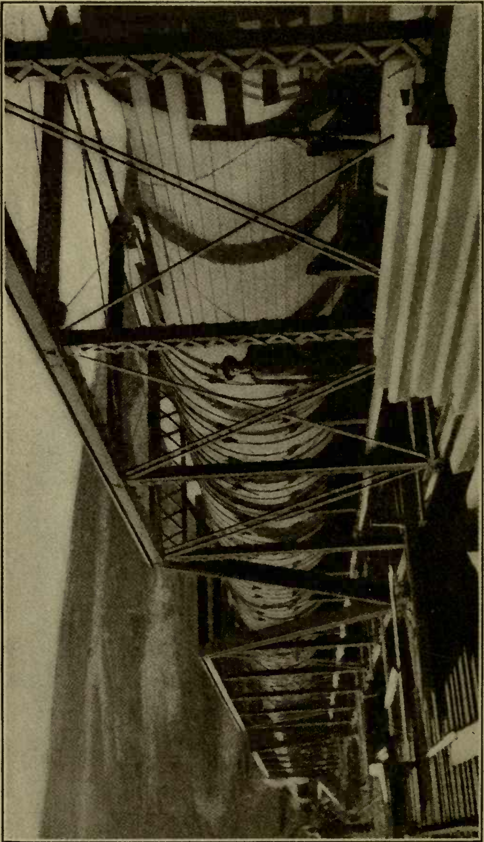


30-Inch Pipe on Bridge Subsequently Boxed in influences on account of its proportionately small surface than is the attenuated shape of the thin sheets in a riveted or welded pipe.

Hence in conditions known to be severe, such as where pipe is to be buried in salt water marshes, stave pipe has been insisted upon by engineers in preference to any other pressure pipe, and in many cases metal pipe abandoned after a few years of service has been replaced by stave pipe. No instance has yet been recorded where stave pipe properly built in the first instance and kept buried and filled with water has started leaking or has given any evidence of weakening, or in fact has afforded any evidence upon which to base an intelligent limitation of its continued usefulness.

As regards the effect of wear of water, when carrying sand, upon the soft wooden staves, which has sometimes been advanced as an objection to wooden pipe, as being likely to shorten its life, we quote from the able report of Mr. S. Fortier, consulting engineer of the Ogden Bench Canal and Water Company:

"Wooden stave pipe is now extensively used throughout the arid West, and wherever care has been exercised in its construction, has produced excellent results. For a time it was thought that a stave pipe would soon decay, but the best practice of late years has demonstrated the fact that when laid below the grade line and consequently kept full of water it is practically indestructible. There was but one thing lacking to prove its general durability, viz., the wear on the staves caused by sediment and gravel in the water.

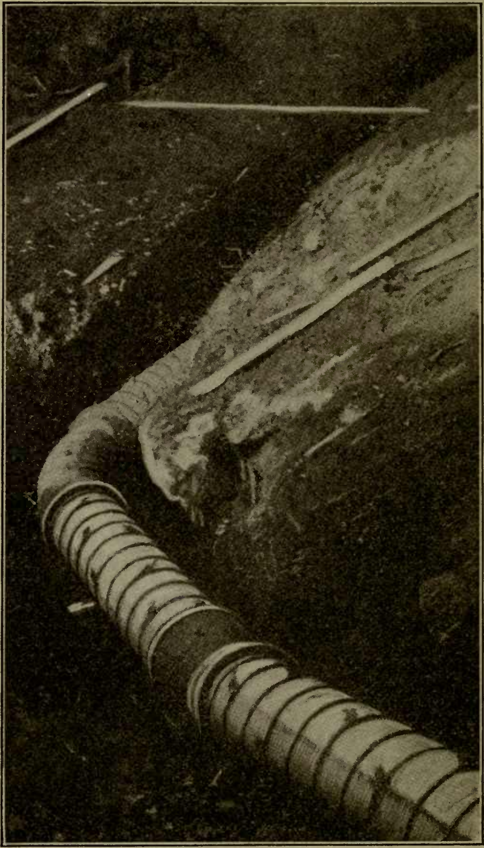


8-Foot Pipe, Crossing River on Steel Bridge, Subsequently Boxed in

Nearly three years ago the author began experimenting in this direction with a view of determining the amount of wear in such piping. A stave pipe of 24 inches diameter, built of California redwood, was laid on a steep grade and water allowed to flow continuously through it. The water seldom covered or touched upon more than four of the bottom staves and had a minimum velocity of 18 feet per second. The character of the water was also the same, as regards sediment, as that flowing in Ogden River. At the end of two years portions of the bottom staves were removed, and, when their thickness after being dried was compared with other staves in the same section of pipe that had never been subjected to any wear, no appreciable diminution in thickness could be observed. The velocity of flow in pipe conduits seldom exceeds six feet per second, so that the amount of wear in the case of the test, the velocity being 18 feet per second, would be about equal to the wear in a conduit on an ordinary grade during a period of six years."

LONGITUDINAL STRENGTH

The absence of circumferential joints in its construction avoids serious local weakening of the strength of the pipe considered as a long tube, and this, taken in connection with its lightness and the possibility of producing tight work even with some water in the trench, has frequently led to its adoption in situations where, owing to the softness of the ground, other pipe would have required special foundation and expensive pumping operations.



18-Inch Pipe, Cast Iron Elbows

LIGHT WEIGHT OF PARTS

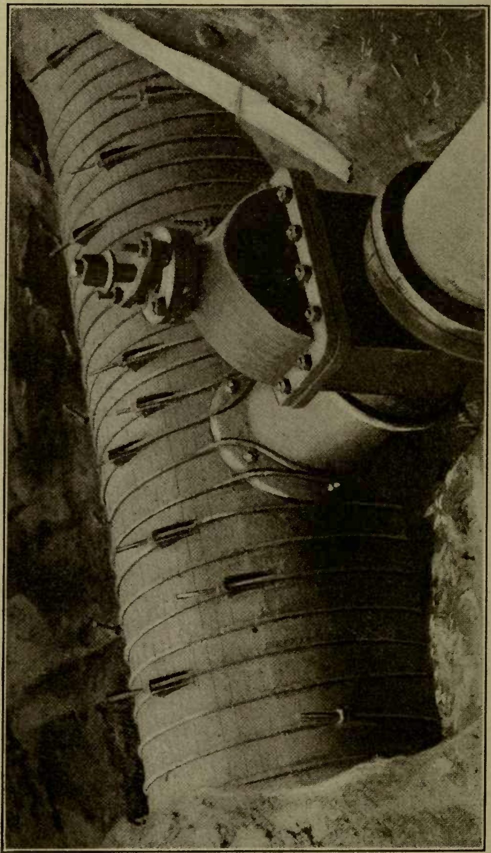
In places along steep side hills and otherwise difficult of access, heavy hoisting apparatus or specially constructed roads can be avoided by the use of stave pipe. All the required material for the largest size pipe can be transported on the backs of mules, handled by at the most two men by hand or raised to the line of work by light cables or tramways. This is of great importance not only in first construction but in the matter of repairs should the work be damaged by land slides or from other exterior causes.

TIGHTNESS

In spite of the enormous proportion of both seam and butt joints, experience has amply shown the possibility of constructing wooden pipe water-tight. Careful tests have been made with pipe lines many miles in length, built by us, where accurate measurements at both ends of the line failed to establish any difference between inflow and outflow. As a deduction from one of these tests, Mr. A. L. Adams in his paper on the "Astoria Water Works" (Am. Soc. C. E. Transactions, Dec., 1896) observes that it "gave results which the author believes have never been surpassed in any other pipe construction of any class."

CARRYING CAPACITY

In comparing cost of different classes of pressure pipe the proper basis is not that of cost per foot for the same diameters alone, nor is it



12-Inch Blow-Off on 30-Inch Pipe

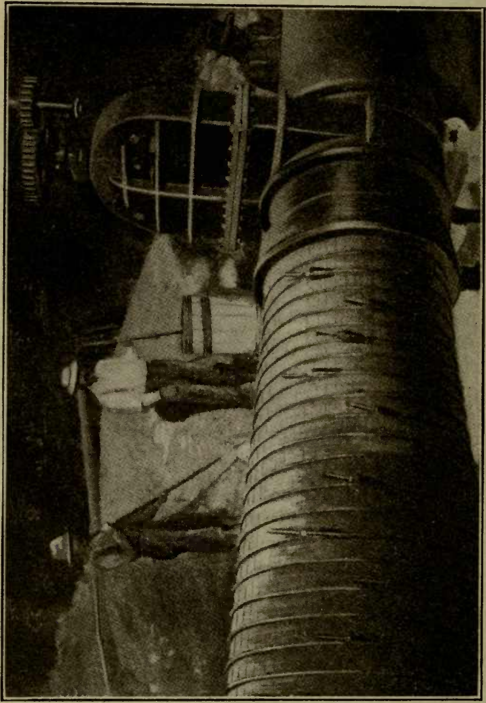
sufficient that the comparative endurance of the pipe be added to these considerations. Pipe is built to convey water, and it is the results obtained that should form the basis. If stave pipe of a certain size will do the same work as a metal pipe of larger size, then the cost of the smaller wooden pipe should be compared with that of the larger metal pipe and a comparison on this impartial basis will still further emphasize the economy to be obtained from the use of stave pipe within the limitations of its safe operation.

The flow experiments on stave pipe that have so far been made may not entirely agree among themselves, any more than is the case with other classes of pipe, nevertheless it is an undisputed fact that the carrying capacity of stave pipe exceeds that of metal pipe, even under most favorable conditions. Entire absence of interior shoulders and smoothness of interior surface account for these results.

While metal pipe is very liable to the formation of tubercles upon its interior surface, rapidly reducing its carrying capacity in the course of even a few years, stave pipe remains smooth and its carrying capacity unaffected by age.

FIXTURES

Gate valves with specially large bells can be inserted in a line of wooden pipe the same as in other pressure pipe, the joints being caulked with oakum and lead. Standard gate valves can be used in connection with short cast iron bell and spigot pieces, having a bell of the necessary size to receive the wooden pipe.



36 to 30-Inch Reducer Connecting with 30-Inch Gate

Connection with other classes of pressure pipe is made by the intervention of a short cast iron bell piece, or by slightly enlarging the end of the wood pipe and lapping the staves over the end of the other pressure pipe.

Connection with branch lines, if of about the same diameter, is made by inserting a cast iron, or, for a very large size, a steel riveted "T" with bells of suitable dimensions. If the diameter of the branch line is less than one-half that of the main line, connection can be made in a more economical manner by bolting a cast iron saddle to the side of the pipe, with a bell at its outer end. Blow-off or drain gates are connected similarly, the cast iron saddle being, however, usually provided at its outer end with either a flat flange or a screw thread to fit a nipple.

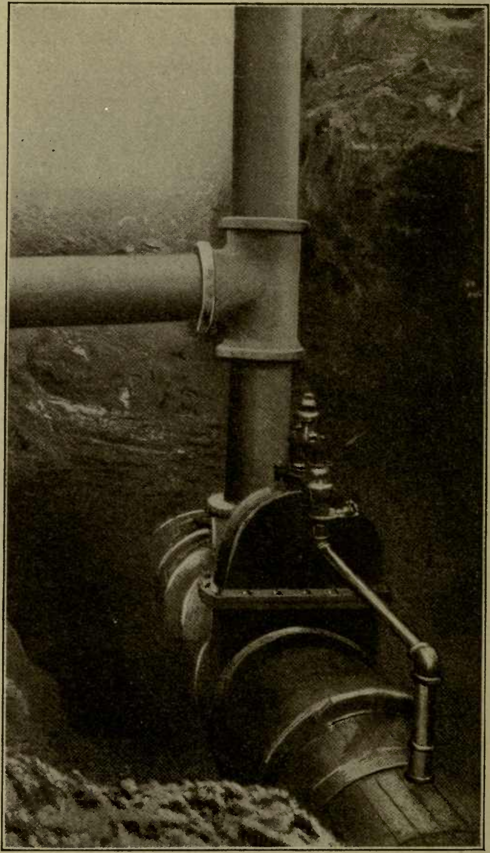
Air valves, relief valves and stand pipes are connected in the same manner. Changes in diameter can be readily made by the planing down of the staves or by the insertion of additional tapering staves.

USES

In a general way it can be said that stave pipe may be employed wherever pressure pipe is required with pressure below 200 feet. It may not be amiss to particularize as to its uses.

DOMESTIC WATER SUPPLY

Stave pipe is peculiarly adapted for the conveyance of water from distant sources, in view of the general possibility of locating and equipping



Stand Pipe with Overflow, Main Gate and Air Inlet on 18-Inch Stave Pipe long supply mains in such a manner as to keep the pressure within the limits of stave pipe construction, and to avoid serious water ram. Many cities receive their supply exclusively or partly through stave pipe, among which the following can be mentioned:

Denver, Colo.; Ogden, Provo and Logan, Utah; Pocatello, Idaho; Butte, Mont.; New Whatcom, Tacoma, Seattle and Clarkston, Wash.; Astoria, Ore.; Oakland, Hollister, Los Angeles and National Soldiers' Home near Santa Monica, Cal.; Abilene, Tex.; Kaslo, B. C.; Calgary, Alberta; St. John, New Brunswick; Lynchburg, Va.; Greensboro, N. C., etc.

IRRIGATION

Wooden flumes, which carry irrigation water on grade over rivers and depressions, are a familiar feature of irrigation canals. They have, however, some serious disadvantages, which render different methods of conveying the water very desirable. Exposed as they are to the action of the wind and sun, the wood warps and cracks, and since they are alternately wet and dry, the wood rots quickly. The trestles upon which they rest form an obstruction to the water in the creeks over which they cross, which, when coming down in freshets, endangers the entire structure.

The pipe, when buried in the ground, is protected from the action of the atmosphere and leaves no obstruction to the flow of surface water over it. It may be kept full of water the year round, or where danger of freezing exists, the water may be drawn off through a gate at the bottom at the end of the irrigation season. In places where flume with ordinary height of trestle can be used, an inverted siphon will often be found more economical.

Where the dip is so great as to put fluming out of the question, a straight pipe line may be run across, frequently saving many miles of canal. Where water is developed from underground sources or where it is pumped to considerable height, it is of importance that great expense having been incurred in its collection, the water should all be saved and not be allowed to seep away in the ground before reaching its destination, to which clear water is particularly liable. Pipe lines instead of canals are for this reason best adapted to conduct water. They will also save whatever evaporation there may be from open ditches, will do away with troublesome growth of algae in this kind of water and with the annual expense of cleaning, and will admit of continued flow during the winter season for filling storage reservoirs.

There is also a saving in the cost of right of way, as they do not show on the surface, and may often be laid for long distances along the county roads.

When water is put upon the land by pumping, pump mains are required, for which our pipe thoroughly recommends itself on account of its economy and great carrying capacity and a continual saving in fuel and operating expenses may be obtained through its use.

A notable instance of a successful irrigation pumping plant is furnished by the works built near Yuma, Arizona, by Messrs. Blaisdell & Hicks, who combined costly pumping machinery of the greatest efficiency with a large wooden main pipe, thereby securing remarkable economy in fuel consumption.

Another instance is the plant of the Spreckels Sugar Company, at Kings City, California, where the water pumped by three 20-inch centrifugal pumps is conducted through a 60-inch pipe three thousand feet long to an elevation about 34 feet above the source of supply.

Stave pipe has been used for irrigation, as is shown in the following list:—

Maxwell Grant, N. M.;

Fort Garland, Colo.;

Berkley Lake, Denver;

Bessemer Ditch, Pueblo;

Parachute, Colo.;

Gothenburg, Neb.;

Yuma, Arizona;

Bear Valley Irrigation Company, Redlands, Cal.;

Kern County Land Company, Bakersfield, Cal.;

Yakima Valley Canal Co., N. Yakima, Wash.;

City of Los Angeles, Cal.;

Mount Nebo Land & Irrigation Co., Salt Lake City, Utah;

Crocker Hoffman Estate, Merced, Cal.;

Poso Irrigation District, Poso, Cal.;

Spreckels Sugar Co., Kings City, Cal.;

Bitter Root Valley Irrigation Co., Hamilton, Mont.;

French Land & Irrigation Co., French, N. M.;

Louisiana Rio Grande Canal Co., McAllen, Texas;

Rio Bravo Irrigation Co., McAllen, Texas;

And many others that could be named.

WATER POWER

With the rapid improvement of hydraulic and electric machinery water power is being utilized on an ever increasing scale.

In the mountainous districts from which such power in the western United States is generally obtained, the construction of open canals along the side-hills is often prohibitive in cost, if not utterly impracticable.

Flume construction is generally possible, but where carried along steep and rocky hill-sides it is frequently very expensive, besides being subject to external injury from fire where on trestle and from rolling boulders, and being liable to interruption from the formation of ice. Occasionally flume construction becomes impracticable where a gradual descent of the country compels the construction of very high trestle. In all such cases the use of stave pipe may be advantageously considered. It can be placed along the hill-sides independent of elevation or grade where natural benches afford an economical foundation, and being covered it is subject neither to danger from fires or destruction from falling boulders, nor to interruption from frost or snow, momentous advantages when the necessity for uninterrupted supply of water to the wheels is considered.

While in first cost in some cases it compares unfavorably with flume, when short life and cost of maintenance of flumes are given due weight, stave pipe will often be found to be most economical. Stave pipe is used for this purpose by the Yuba Electric Company, near Marysville; the Floriston Pulp & Paper Company, at Floriston, all in California; and the Reno Water, Land and Light Company at Reno, Nevada; the Utah Sugar Co., at their Bear River plant; the City of Springville, Utah; the Vancouver Power Co., at Vancouver, B. C.; Cornell University, Ithaca, N. Y.; Great Northern Power Co., Duluth, Minn.; Northern Idaho & Montana Power Co., Big Fork, Mont.; Hydro Electric Co., Bodie, Cal.; Michoacan Power Co., Villasenor, Mexico; Nevada California Power Co., Bishop, Cal. Also in a number of other places that could be enumerated.

OUTFALL SEWERS

Sewerage has frequently to be conducted long distances to be discharged in the ocean, in natural streams or on sewer farms or filter beds. Where the pipe can be maintained full at intervals or where it lies in wet soil, or where sewage is pumped, conditions for the use of wooden pipe are favorable. In comparison with ordinary sewer pipe it has the advantage that it can be built tight even with a small amount of water in the trench, and that in soft and marshy soil no foundation is required, as the pipe when full is no heavier than the soil it displaces and has great longitudinal strength. Stave pipe has been so used in Los Angeles, Hollister, Palo Alto, Menlo Park and San Rafael, all in California; and the important fact that wood is in no way affected by the frequent acidulous character of the sewage is largely in its favor in comparing it with metal pressure pipes.

OTHER USES

Stave pipe has been used for a number of other purposes, such as for discharge pipe of hydraulic dredges, for caissons in wharf and foundation construction, etc., and has given satisfaction in every instance.

TESTIMONIALS

We can refer you to a number of pipe lines installed by us many years ago, and, if desired, can send you testimony from the owners regarding these various installations.

TABLES ON FLOW THROUGH WOODEN STAVE PIPE

PREFACE

It is well known that the carrying capacity of water pipe depends upon the smoothness of its interior surface. In this respect wooden pipe not only surpasses all other pressure pipe in the market, when it is new, but its capacity does not decrease with use, as is the case with wrought iron, steel and cast iron pipe. Our pipe will carry from ten to twenty per cent more water than iron or steel pipe when both are new and from thirty to fifty per cent more when both are ten years old.

Until recently the experiments on flow through wooden pipes have been very meager, not covering sufficient range of diameters and velocities to warrant the engineer in using the results as to delivery, without allowing an ample factor of safety. However, of late years, wooden pipe has entered so largely in the construction of pressure conduits; and, as a result, many experiments have been made to determine more closely its delivering capacity. The results have been plotted logarithmically, using the friction heads as ordinates and the velocities as abscissas, the plotted lines representing the diameters. (Proceedings American Society of Civil Engineers, Oct., 1902.) This logarithmic plotting developed quite harmonious results, and led to suggesting a formula of the form $H = m V^n$ where

H = friction head per 1000 ft. of pipe.

V = velocity in feet per second.

m = a constant depending on the diameter.

n = exponent of the velocity.

The value of "m" is obtained directly from the logarithmic plotting by placing "V"=1. "n" is also obtained from this plotting by scaling the slope of the plotted lines. In the majority of experiments referred to the value of "n" developed was 1.73.

It is not the purpose of this preface to go into a technical discussion of the formula above suggested, but the results obtained therefrom seem to harmonize with actual experiment more nearly than those derived from the Kutter formula, which had been generally used, or from any other formula which has come under our observation. We have therefore accepted the new formula as the safest basis at present available and have used same in the compilation of the following tables.

The tables may be used—

First—To ascertain the loss of head or frictional resistance within any size pipe, while discharging given quantities of water.

Second—To find the maximum quantity of water which any size pipe will discharge under a given head.

Third—To determine the size of pipe required to conduct a given quantity of water under a given head.

The total head required to force water into and through a line of pipe consists of three parts:

h_1. The head required to impart velocity to the water.

h_2. The head required to overcome resistance of contraction at the point of entrance.

h_3. The head required to overcome frictional resistance in the pipe itself.

h_1 is solely dependent upon the velocity of the water in the pipe, and is given in the first columns of the tables. h_2 depends upon the facility with which the water enters the pipe, and may be approximated from h_1 as follows:

Pipe projecting into reservoir $h_2 = 0.96\ h_1$.

Pipe flush with side of reservoir $h_2 = 0.47\ h_1$.

Pipe with funnel-shaped intake $h_2 = 0.06\ h_1$.

h_3 is directly proportionate to the length of the pipe, and becomes all-important for long pipe lines, in which case h_1 and h_2 may often be entirely neglected. This is not the case with short pipe lines, such as siphons for irrigation canals, especially if the water is to attain a high rate of speed.

The tables are based on the assumption of pipe lines perfectly straight, both as regards alignment and grade.

TEN-INCH PIPE.

Head in Feet required to produce Velocity.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	FRICTION HEAD in Feet		Discharge in Million Gallons per twenty-four Hours.
			Per 1,000 Feet	Per Mile	
0.00	0.44	0.23	0.10	0.53	0.14
0.00	0.49	0.26	0.12	0.64	0.16
0.00	0.55	0.29	0.15	0.79	0.18
0.01	0.65	0.35	0.2	1.06	0.22
0.01	0.83	0.45	0.3	1.58	0.29
0.01	0.98	0.53	0.4	2.11	0.34
0.02	1.10	0.59	0.5	2.64	0 38
0.03	1.24	0.67	0.6	3.17	0.43
0.03	1.36	0.74	0.7	3.70	0.47
0.03	1.47	0.78	0.8	4.22	0.50
0.04	1.57	0.85	0.9	4.75	0.55
0.04	1.66	0.9	1.0	5.28	0.58
0.07	2.12	1.1	1.5	7.92	0.75
0.10	2.50	1.3	2	10.56	0.88
0.15	3.16	1.7	3	15.84	1.10
0.21	3.72	2.0	4	21.12	1.29
0.28	4.23	2.3	5	26.40	1.49
0.34	4.70	2.5	6	31.68	1.62
0.41	5.15	2.8	7	36.96	1 81
0.48	5.55	3 0	8	42.24	1.94
0.55	5.93	3 2	9	47.52	2.07
0.62	6.30	3.4	10	52.80	2.21
0.76	7.00	3.8	12	63.36	2.46
0.91	7.65	4.1	14	73.92	2.66
1.0	8.26	4.4	16	84.48	2.85
1.2	8.85	4.8	18	95.04	3.11
1.4	9.42	5.1	20	105.60	3.30

TWELVE-INCH PIPE.

Head in Feet required to produce Velocity.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	FRICTION HEAD in Feet		Discharge in Million Gallons per twenty-four Hours.
			Per 1,000 Feet	Per Mile	
0.01	0 49	0.40	0.10	0.53	0.25
0.01	0.54	0.45	0.12	0.64	0.29
0.01	0.62	0.50	0.15	0.79	0.32
0.01	0.73	0.60	0.20	1.06	0.38
0.01	0.92	0.76	0.30	1.58	0.49
0.02	1.08	0.89	0.4	2.11	0.57
0.02	1 23	1.01	0.5	2.64	0.65
0.03	1.37	1.13	0.6	3.17	0.73
0.04	1.50	1.25	0.7	3.70	0.80
0.04	1.63	1.34	0.8	4.22	0.86
0.05	1.73	1.43	0.9	4.75	0.92
0.05	1.83	1.52	1.0	5.28	0.98
0.07	2.33	1.8	1.5	7.92	1.16
0 12	2.75	2.1	2	10.56	1.36
0.19	3.48	2.7	3	15.84	1.74
0.26	4.10	3.2	4	21.12	2.07
0.34	4.69	3.6	5	26.40	2.33
0.42	5.20	4.0	6	31.68	2.59
0.51	5.70	4.4	7	36.96	2.85
0.59	6.15	4.8	8	42.24	3.12
0.68	6.60	5.1	9	47.54	3.30
0.76	6.98	5.4	10	52.80	3.49
0.92	7.70	6.0	12	63.36	3.88
1.1	8.45	6.5	14	73.92	4.21
1.3	9.10	7.1	16	84.48	4.60
1.5	9.75	7.6	18	95.04	4.92
1.7	10.40	8.1	20	105.60	5.25

FOURTEEN-INCH PIPE.

Head in Feet required to produce Velocity.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	FRICTION HEAD in Feet		Discharge in Million Gallons per twenty-four Hours.
			Per 1,000 Feet	Per Mile	
0.01	0.53	0.57	0.10	0.53	0.36
0.01	0.59	0.63	0.12	0.64	0.40
0.01	0.67	0.72	0.15	0 79	0.46
0.01	0.80	0.86	0.20	1.06	0.55
0.02	1.00	1.07	0.30	1.58	0.69
0.02	1.18	1.26	0.4	2.11	0.81
0.03	1.35	1.44	0.5	2.64	0.93
0.04	1.50	1.60	0.6	3.17	1.03
0.04	1.64	1.76	0.7	3.70	1.14
0.05	1.78	1.90	0.8	4.22	1.23
0.06	1.89	2.02	0.9	4.75	1.30
0.06	2.00	2.14	1.0	5.28	1.38
0.10	2.53	2.7	1.5	7.92	1.75
0.14	2.98	3.2	2.0	10.56	2.07
0.22	3.78	4.0	3	15.84	2.60
0.31	4.45	4.7	4	21.12	3.03
0.40	5.10	5.4	5	26.40	3.50
0.50	5.65	6.0	6	31.68	3 87
0.60	6.19	6.6	7	36.96	4 27
0.69	6.68	7.1	8	42.24	4.58
0.79	7.13	7.6	9	47.52	4,90
0.88	7.58	8.1	10	52.80	5.23
1.1	8.40	9.0	12	63.36	5.82
1.3	9.20	9.8	14	73.92	6.32
1.5	9.90	10.6	16	84.48	6.85
1.8	10.7	11.4	18	95.04	7.39
2.0	11.4	12.2	20	105.60	7.90

SIXTEEN-INCH PIPE.

Head in Feet required to produce Velocity.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	FRICTION HEAD in Feet		Discharge in Million Gallons per twenty-four Hours.
			Per 1,000 Feet	Per Mile	
0.01	0.59	0.8	0.10	0.53	0.51
0.01	0.69	0.9	0.12	0.64	0.58
0.01	0.72	1.0	0.15	0.79	0.65
0.01	0.85	1.2	0.2	1.06	0 77
0.02	1.08	1.5	0.3	1.58	0.97
0.03	1.27	1.8	0.4	2.11	1.16
0.03	1.45	2.0	0.5	2.64	1.30
0.04	1.61	2.2	0.6	3.17	1.45
0.05	1.77	2.5	0.7	3.70	1.62
0.06	1.90	2.7	0.8	4.22	1.74
0.06	2.03	2.8	0.9	4.75	1.81
0.07	2.17	3.0	1.0	5.28	1.94
0.12	2.74	3.8	1.5	7.92	2.46
0.16	3.24	4.5	2	10.56	2.92
0.26	4.10	5.7	3	15.84	3.69
0.36	4.83	6.7	4	21.12	4.34
0.47	5.50	7.7	5	26.40	4.98
0.58	6.10	8.5	6	31.68	5.50
0.70	6.70	9.3	7	36.96	6.02
0.81	7.22	10.0	8	42.24	6.48
0.93	7.73	10.8	9	47.52	7.05
1.2	8.20	11.4	10	52.80	7.39
1.3	9.10	12.7	12	63.36	8.21
1.5	9.91	13.8	14	73.92	8.95
1.8	10.7	14.9	16	84.48	9.55
2.1	11.5	16.0	18	95.04	10.3
2.3	12.2	17.0	20	105.60	11.0

EIGHTEEN-INCH PIPE.

Head in Feet required to produce Velocity.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	FRICTION HEAD in Feet		Discharge in Million Gallons per twenty-four Hours.
			Per 1,000 Feet	Per Mile	
0.01	0.61	1.1	0.10	0.53	0.71
0.01	0.68	1.2	0.12	0.64	0.77
0.01	0.77	1.4	0.15	0.79	0.90
0.01	0.91	1.6	0.20	1.06	1.03
0.02	1.15	2.0	0.30	1.58	1.30
0.03	1.36	2.4	0.40	2.11	1.55
0.04	1.55	2.7	0.50	2.64	1.74
0.05	1.72	3.0	0.60	3.17	1.94
0.05	1.87	3.3	0.70	3.70	2.14
0.06	2.00	3.5	0.80	4.22	2.26
0.07	2.17	3.8	0.90	4.75	2.46
0.08	2.30	4.1	1.0	5.28	2.66
0.13	2.91	5.1	1.5	7.92	3.30
0.18	3.43	6.1	2	10.56	3.95
0.29	4.35	7.7	3	15.84	4.98
0.41	5.15	9.1	4	21.12	5.89
0.53	5.85	10.3	5	26.40	6.66
0.65	6.49	11.5	6	31.68	7.45
0.78	7.08	12.5	7	36.96	8.10
0.91	7.66	13.5	8	42.24	8.75
1.0	8.20	14.5	9	47.52	9.40
1.2	8.70	15.4	10	52.80	9.99
1.4	9.6	17.0	12	63.36	11.0
1.8	10.7	18.9	14	73.92	12.2
2.1	11.5	20.3	16	84.48	13.2
2.3	12.2	21.6	18	95.04	14.0
2.7	13.1	23.2	20	105.60	15.0

TWENTY-INCH PIPE.

Head in Feet required to produce Velocity.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	FRICTION HEAD in Feet		Discharge in Million Gallons per twenty-four Hours.
			Per 1,000 Feet	Per Mile	
0.01	0.65	1.4	0.10	0.53	0.90
0.01	0.72	1.6	0.12	0.64	1.03
0.01	0.82	1.8	0.15	0.79	1.16
0.01	0.97	2.1	0.2	1.06	1.36
0.02	1.22	2.7	0.3	1.58	1.75
0.03	1.44	3.1	0.4	2.11	2.01
0.04	1.64	3.6	0.5	2.64	2.33
0.05	1.82	4.0	0.6	3.17	2.59
0.06	2.00	4.4	0.7	3.70	2.85
0.07	2.13	4.6	0.8	4.22	2.98
0.08	2.30	5.0	0.9	4.75	3.24
0.09	2.45	5.3	1.0	5.28	3.43
0.15	3.10	6.8	1.5	7.92	4.41
0.21	3.66	8.0	2	10.56	5.18
0.33	4.63	10.1	3	15.84	6.55
0.46	5.45	11.9	4	21.12	7.70
0.60	6 20	13.5	5	26.40	8.75
0.74	6.90	15.1	6	31.68	9.80
0.88	7.52	16.4	7	36.96	10.6
1.0	8.15	17.8	8	42.24	11.5
1.2	8.73	19.0	9	47.52	12.3
1.3	9.28	20.2	10	52.80	13.0
1.7	10.3	22.5	12	63.36	14.5
2.0	11.3	24.7	14	73.92	15.0
2.3	12.1	26.4	16	84.48	17.1
2.6	13.0	28.4	18	95.04	18.4
3.0	13.8	30.1	20	105.60	19.5

TWENTY-TWO-INCH PIPE.

Head in Feet required to produce Velocity.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	FRICTION HEAD in Feet		Discharge in Million Gallons per twenty-four Hours.
			Per 1,000 Feet	Per Mile	
0.01	0.68	1.8	0.10	0.53	1.16
0.01	0.76	2.0	0.12	0.64	1.30
0.01	0.86	2.3	0.15	0.79	1.49
0.02	1.02	2.7	0.20	1.06	1.75
0.03	1.29	3.4	0.30	1.58	2.21
0.04	1.51	4.0	0.40	2.11	2.59
0.05	1.73	4.6	0.50	2.64	2.98
0.06	1.93	5.1	0.60	3.17	3.30
0.07	2.10	5.5	0.70	3.70	3.56
0.08	2.25	5.9	0.80	4.22	3.82
0.09	2.43	6.4	0.90	4.75	4.15
0.10	2.58	6.8	1.0	5.28	4.40
0.17	3.28	8.7	1.5	7.92	5.60
0.23	3.86	10.2	2.0	10.56	6.61
0.37	4.88	12.9	3	15.84	8.35
0.52	5.76	15.2	4	21.12	9.85
0.67	6.55	17.3	5	26.40	11.2
0.82	7.28	19.2	6	31.68	12.4
1.0	7.95	21.0	7	36.96	13.6
1.1	8.55	22.6	8	42.24	14.6
1.3	9.20	24.3	9	47.52	15.8
1.5	9.78	25.8	10	52.80	16.8
1.8	10.8	28.5	12	63.36	18.4
2.2	11.8	31.1	14	73.92	20.3
2.6	12.9	34.0	16	84.48	22.1
3.0	13.8	36.4	18	95.04	23.5
3.3	14.6	38.5	20	105.60	24.8

TWENTY-FOUR-INCH PIPE.

Head in Feet required to produce Velocity.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	FRICTION HEAD in Feet		Discharge in Million Gallons per twenty-four Hours.
			Per 1,000 Feet	Per Mile	
0.01	0.71	2.2	0.10	0.53	1.42
0.01	0.79	2.5	0.12	0.64	1.62
0.01	0.90	2.8	0.15	0.79	1.81
0.02	1.06	3.3	0.2	1.06	2.14
0.03	1.35	4.2	0.3	1.58	2.72
0.04	1.59	5.0	0.4	2.11	3.24
0.05	1.81	5.7	0.5	2.64	3.69
0.06	2.01	6.3	0.6	3.17	4.07
0.08	2.20	6.9	0.7	3.70	4.46
0.09	2.36	7.4	0.8	4.22	4.79
0.10	2.55	8.0	0.9	4.75	5.19
0.11	2.70	8.5	1.0	5.28	5.50
0.18	3.41	10.7	1.5	7.92	6.95
0.25	4.03	12.7	2	10.56	8.20
0.40	5.10	16.0	3	15.84	10.1
0.56	6.00	18.9	4	21.12	12.2
0.73	6.83	21.5	5	26.40	13.9
0.89	7.60	23.9	6	31.68	15.5
1.1	8.28	26.0	7	36.96	16.8
1.2	8.95	28.0	8	42.24	18.1
1.4	9.55	30.0	9	47.52	19.4
1.6	10.2	32.0	10	52.80	20.7
2.0	11.4	35.8	12	63.36	23.2
2.4	12.4	39.0	14	73.92	25.2
2.8	13.4	42.1	16	84.48	27.3
3.2	14.3	44.9	18	95.04	29.1
3.6	15.2	48.0	20	105.60	31.1

TWENTY-SIX - INCH PIPE.

Head in Feet required to produce Velocity.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	FRICTION HEAD in Feet		Discharge in Million Gallons per twenty-four Hours.
			Per 1,000 Feet	Per Mile	
0.01	0.75	2.7	0.10	0..53	1.75
0.01	0.83	3.0	0.12	0.64	1.94
0.01	0.95	3.5	0.15	0.79	2.27
0.02	1.12	4.1	0.20	1.06	2.66
0.03	1.42	5.2	0.30	1.58	3.37
0.04	1.68	6.1	0.40	2.11	3.95
0.06	1.90	6.9	0.50	2.64	4.47
0.07	2.12	7.7	0.60	3.17	4.99
0.08	2.31	8.4	0.70	3.70	5.43
0.09	2.47	9.0	0.80	4.22	5.82
0.11	2.67	9.7	0.90	4.75	6.29
0.12	2.83	10.3	1.00	5.28	6.65
0.20	3.60	13.1	1.50	7.92	8.49
0.28	4.25	15.4	2	10.56	9.99
0.47	5.50	20.0	3	15.84	12.9
0.63	6.35	23.1	4	21.12	14.9
0.81	7.21	26.2	5	26.40	16.8
0.99	8.00	29.1	6	31.68	18.9
1.2	8.77	31.9	7	36.96	20.7
1.4	9.46	34.4	8	42.24	22.1
1.6	10.1	36.7	9	47.52	23.8
1.8	10.7	38.9	10	52.80	25.2
2.2	11.9	43.2	12	63.36	28.0
2.7	13.1	47.6	14	73 92	30.7
3.1	14.1	51.3	16	84.48	33.4
3.5	15.0	54.5	18	95.04	35.9
4.0	16.0	58.2	20	105.60	37.7

TWENTY-EIGHT-INCH PIPE.

Head in Feet required to produce Velocity.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	FRICTION HEAD in Feet Per 1,000 Feet	FRICTION HEAD in Feet Per Mile	Discharge in Million Gallons per twenty-four Hours.
0.01	0.78	3.3	0.10	0.53	2.14
0.01	0.87	3.7	0.12	0.64	2.39
0.02	0.99	4.2	0.15	0.79	2.71
0.02	1.16	5.0	0.2	1.06	3.24
0.03	1.47	6.3	0.3	1.58	4.08
0.05	1.75	7.5	0.4	2.11	4.86
0.06	1.98	8.5	0.5	2.64	5.50
0.08	2.20	9.4	0.6	3.17	6.09
0.09	2.41	10.3	0.7	3.70	6.66
0.10	2.58	11.0	0.8	4.22	7.12
0.12	2.79	11.9	0.9	4.75	7.70
0.14	2.95	12.6	1.0	5.28	8.15
0.22	3.75	16.0	1.5	7.92	10.3
0.30	4.41	18.9	2	10.56	12.2
0.49	5.60	23.9	3	15.84	15.5
0.68	6.60	28.2	4	21.12	18.3
0.87	7.50	32.1	5	26.40	20.8
1.1	8.35	35.7	6	31.68	23.2
1.3	9.10	38.9	7	36.96	25.2
1.5	9.85	42.1	8	42.24	27.2
1.7	10.5	44.9	9	47.52	29.0
2.0	11.2	47.9	10	52.80	31.0
2.4	12.4	53.0	12	63.36	34.3
2.9	13.6	58.2	14	73.92	37.7
3.3	14.6	62.4	16	84.48	40.5
3.8	15.6	66.7	18	95.04	43.1
4.3	16.6	71.0	20	105.60	46.0

THIRTY-INCH PIPE.

Head in Feet required to produce Velocity.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	FRICTION HEAD in Feet		Discharge in Million Gallons per twenty-four Hours.
			Per 1,000 Feet	Per Mile	
0.01	0.81	4.0	0.10	0.53	2.59
0.01	0.90	4.4	0.12	0.64	2.85
0.02	1.03	5.0	0.15	0.79	3.24
0.02	1.21	5.9	0.20	1.06	3.82
0.04	1.53	7.5	0.30	1.58	4.85
0.05	1.81	8.9	0.40	2.11	5.76
0.07	2.06	10.1	0.50	2.64	6.52
0.08	2.29	11.2	0.6	3.17	7.25
0.10	2.50	12.3	0.7	3.70	7.98
0.11	2.68	13.2	0.8	4.22	8.55
0.13	2.89	14.2	0.9	4.75	9.20
0.14	3.05	15.0	1.0	5.28	9.71
0.24	3.90	19.2	1.5	7.92	12.4
0.33	4.61	22.6	2	10.56	14.6
0.51	5.85	28.7	3	15.84	18.6
0.74	6.88	33.8	4	21.12	21.9
0.95	7.81	38.3	5	26.40	24.7
1.2	8.7	42.7	6	31.68	27.6
1.4	9.5	46.6	7	36.96	30.2
1.7	10.3	50.6	8	42.24	32.7
1.9	10.9	53.5	9	47.52	34.6
2.1	11.6	56.9	10	52.80	36.7
2.5	12.8	62.8	12	63.36	40.6
3.1	14.1	69.2	14	73.92	44.8
3.6	15.2	74.6	16	84.48	48.2
4.1	16.2	79.5	18	95.04	51.5
4.6	17.3	84.9	20	105.60	55.0

THIRTY-TWO-INCH PIPE.

Head in Feet required to produce Velocity.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	FRICTION HEAD in Feet		Discharge in Million Gallons per twenty-four Hours.
			Per 1,000 Feet	Per Mile	
0.01	0.84	4.7	0.10	0.53	3.04
0.01	0.93	5.2	0.12	0.64	3.46
0.02	1.06	5.9	0.15	0.79	3.82
0.02	1.26	7.1	0.2	1.06	4.60
0.04	1.58	8.8	0.3	1.58	5.70
0.05	1.87	10.4	0.4	2.11	6.73
0.07	2.13	11.9	0.5	2.64	7.70
0.09	2.37	13.2	0.6	3.17	8.55
0.10	2.58	14.4	0.7	3.70	9.33
0.12	2.76	15.4	0.8	4.22	9.98
0.14	2.96	16.5	0.9	4.75	10.7
0.15	3.15	17.6	1.0	5.28	11.4
0.25	4.01	22.4	1.5	7.92	14.5
0.35	4.75	26.5	2	10.56	17.1
0.56	6.00	33.5	3	15.84	21.7
0.77	7.05	39.4	4	21.12	25.4
1.0	8.05	44.9	5	26.40	29.1
1.2	8.95	50.0	6	31.68	32.4
1.5	9.80	54.7	7	36.96	35.4
1.7	10.5	58.6	8	42.24	37.8
2.0	11.2	62.6	9	47.52	40.6
2.2	11.9	66.5	10	52.80	43.0
2.7	13.2	73.7	12	63.36	47.8
3.3	14.5	81.0	14	73.92	52.3
3.8	15.6	87.1	16	84.48	56.4
4.4	16.8	93.8	18	95.04	60.5
4.9	17.8	99.4	20	105.60	64.5

THIRTY-FOUR-INCH PIPE.

Head in Feet required to produce Velocity.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	FRICTION HEAD in Feet		Discharge in Million Gallons per twenty-four Hours.
			Per 1,000 Feet	Per Mile	
0.01	0.87	5.5	0.10	0.53	3.56
0.01	0.96	6.0	0.12	0.64	3.88
0.02	1.10	6.9	0.15	0.79	4.46
0.03	1.30	8.2	0.2	1.06	5.31
0.04	1.64	10.3	0.3	1.58	6.65
0.06	1.93	12.2	0.4	2.11	7.80
0.08	2.20	13.9	0.5	2.64	9.00
0.09	2.45	15.4	0.6	3.17	9.99
0.11	2.68	16.9	0.7	3.70	10.9
0.13	2.86	18.0	0.8	4.22	11.6
0.15	3.09	19.5	0.9	4.75	12.7
0.17	3.28	20.7	1.0	5.28	13.4
0.27	4.15	26.2	1.5	7.92	17.0
0.37	4.90	30.9	2	10.56	20.0
0.60	6.20	39.1	3	15.84	25.3
0.83	7.30	46.0	4	21.12	29.8
1.1	8.31	52.4	5	26.40	34.0
1.3	9.25	58.3	6	31.68	38.5
1.6	10.2	64.3	7	36.96	41.8
1.8	10.8	68.1	8	42.24	44.1
2.1	11.6	73.1	9	47.52	47.4
2.4	12.4	78.2	10	52.80	50.8
2.9	13.7	86.4	12	63.36	56.0
3.5	15.0	94.6	14	73.92	61.1
4.1	16.2	102	16	84.48	66.1
4.7	17.3	109	18	95.04	70.5
5.3	18.4	116	20	105.60	75.1

THIRTY-SIX-INCH PIPE.

Head in Feet required to produce Velocity.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	FRICTION HEAD in Feet		Discharge in Million Gallons per twenty-four Hours.
			Per 1,000 Feet	Per Mile	
0.01	0.89	6.3	0.10	0.53	4.07
0.02	0.99	7.0	0.12	0.64	4.53
0.02	1.13	8.0	0.15	0.79	5.18
0.03	1.35	9.5	0.2	1.06	6.15
0.05	1.70	12.0	0.3	1.58	7.77
0.06	2.00	14.1	0.4	2.11	9.10
0.08	2.27	16.0	0.5	2.64	10.3
0.10	2.51	17.7	0.6	3.17	11.5
0.12	2.76	19.5	0.7	3.70	12.6
0.14	2.95	20.8	0.8	4.22	13.5
0.16	3.19	22.5	0.9	4.75	14.5
0.18	3.38	23.9	1.0	5.28	15.5
0.29	4.28	30.3	1.5	7.92	19.5
0.40	5.06	35.8	2	10.56	23.1
0.64	6.40	45.2	3	15.84	29.2
0.89	7.55	53.4	4	21.12	34.5
1.2	8.60	60.8	5	26.40	39.4
1.4	9.55	67.5	6	31.68	43.6
1.7	10.4	73.5	7	36.96	47.6
2.0	11.2	79.2	8	42.24	51.2
2.2	12.0	84.8	9	47.52	54.8
2.6	12.8	90.5	10	52.80	58.5
3.1	14.2	100	12	63.36	64.8
3.7	15.5	109	14	73.92	70.5
4.4	16.8	119	16	84.48	77.0
5.0	17.9	126	18	95.04	81.5
5.6	19.0	134	20	105.60	86.8

THIRTY-EIGHT-INCH PIPE.

Head in Feet required to produce Velocity.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	FRICTION HEAD in Feet		Discharge in Million Gallons per twenty-four Hours.
			Per 1,000 Feet	Per Mile	
0.01	0.92	7.2	0.10	0.53	4 65
0.02	1.03	8.1	0.12	0.64	5.24
0.02	1.16	9.1	0.15	0.79	5.89
0.03	1.38	10.9	0.2	1.06	7 05
0.03	1.75	13.8	0.3	1.58	8.95
0.07	2.05	16.1	0.4	2.11	10.2
0.09	2,35	18.5	0.5	2.64	12.6
0.11	2.60	20.5	0.6	3.17	13.2
0.13	2.85	22.4	0.7	3.70	14.5
0.14	3.02	23.8	0.8	4.22	15.4
0.17	3.28	25.8	0.9	4.75	16.7
0.19	3.48	27.4	1.0	5.28	17.7
0.30	4.40	34.6	1.5	7.92	23.3
0.42	5.21	41.0	2	10.56	26.6
0.68	6.60	52.0	3	15.84	33.7
0.94	7.75	61.0	4	21.12	39.5
1.2	8.81	69.4	5	26.40	45.0
1.5	9.80	77.2	6	31.68	50.0
1.8	10.7	84.3	7	36.96	54.7
2.1	11.6	91.4	8	42.24	59.3
2.4	12.4	97.7	9	47.52	63.0
2.7	13.2	104	10	52.80	67.5
3.3	14.6	115	12	63.36	74.5
4.0	16.0	126	14	73.92	81.5
4.6	17.2	135	16	84.48	87.5
5.3	18.5	146	18	95.04	94.4
5.9	19.5	154	20	105.60	99.9

FORTY-INCH PIPE.

Head in Feet required to produce Velocity.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	FRICTION HEAD in Feet		Discharge in Million Gallons per twenty-four Hours.
			Per 1,000 Feet	Per Mile	
0.01	0.95	8.3	0.10	0.53	5.35
0.02	1.05	8.8	0.12	0.64	5.69
0.02	1.20	10.5	0.15	0.79	6.80
0.03	1.42	12.4	0.2	1.06	8.05
0.05	1.80	15.7	0.3	1.58	10.1
0.07	2.12	18.5	0.4	2.11	12.0
0.09	2.40	20.9	0.5	2.64	13.5
0.11	2.67	23.3	0.6	3.17	15.1
0.13	2.92	25.5	0.7	3.70	16.5
0.15	3.12	27.2	0.8	4.22	17.6
0.18	3.37	29.4	0.9	4.75	19.0
0.20	3.58	31.2	1.0	5.28	20.2
0.32	4.53	39.5	1.5	7.92	25.6
0.45	5.35	46.7	2	10.56	30.2
0.72	6.80	59.3	3	15.84	38.2
0.99	7.98	69.7	4	21.12	45.1
1.3	9.09	79.3	5	26.40	51.5
1.6	10.1	88.1	6	31.68	57.1
1.9	11.0	96.0	7	36.96	62.2
2.2	11.9	104	8	42.40	67.3
2.5	12.7	111	9	47.52	72.0
2.8	13.5	118	10	52.80	76.5
3.4	15.1	132	12	63.36	85.5
4.2	16.5	144	14	73.92	93.2
4.9	17.8	155	16	84.48	100.5
5.6	19.0	166	18	95.04	107.5
6.3	20.1	175	20	105.60	114.5

FORTY-TWO - INCH PIPE.

Head in Feet required to produce Velocity.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	FRICTION HEAD in Feet		Discharge in Million Gallons per twenty-four Hours.
			Per 1,000 Feet	Per Mile	
0.01	0.97	9.3	0.10	0.53	6.01
0.02	1.07	10.3	0.12	0.64	6.65
0.02	1.23	11.8	0.15	0.79	7.65
0.03	1.46	14.0	0.2	1.06	9.08
0.05	1.84	17.7	0.3	1.58	11.5
0.07	2.17	20.9	0.4	2.11	13.5
0.09	2.47	23.8	0.5	2.64	15.4
0.12	2.75	26.5	0.6	3.17	17.8
0.14	3.00	28.9	0.7	3.70	18.7
0.16	3.20	30.8	0.8	4.22	20.0
0.18	3.46	33.3	0.9	4.75	21.6
0.22	3.68	35.4	1.0	5.28	22.9
0.34	4.65	44.7	1.5	7.92	29.0
0.47	5.50	52.9	2	10.56	34.1
0.75	6.95	66.9	3	15.84	43.3
1.0	8.20	78.9	4	21.12	51.0
1.3	9.30	89.5	5	26.40	57.5
1.7	10.4	100	6	31.68	64.8
2.0	11.3	109	7	36.96	70.5
2.3	12.2	117	8	42.24	75.7
2.7	13.1	126	9	47.52	81.6
3.0	14.0	135	10	52.80	87.5
3.7	15.5	149	12	63.36	96.5
4.5	17.0	164	14	73.92	106
5.2	18.2	175	16	84.48	113
6.0	19.6	189	18	95.04	122
6.7	20.7	199	20	105.60	129

FORTY-FOUR-INCH PIPE.

Head in Feet required to produce Velocity.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	FRICTION HEAD in Feet		Discharge in Million Gallons per twenty-four Hours.
			Per 1,000 Feet	Per Mile	
0.02	1.00	10.6	0.10	0.53	6.85
0.02	1.12	11.8	0.12	0.64	7.64
0.03	1.27	13.4	0.15	0.79	8.68
0.04	1.50	15.8	0.2	1.06	10.2
0.06	1.90	20.0	0.3	1.58	12.9
0.08	2.25	23.7	0.4	2.11	15.4
0.10	2.55	26.9	0.5	2.64	17.4
0.12	2.82	29.8	0.6	3.17	19.4
0.15	3.10	32.7	0.7	3.70	21.3
0.17	3.30	34.8	0.8	4.22	22.5
0.20	3.57	37.7	0.9	4.75	24.5
0.22	3.78	39.9	1.0	5.28	25.7
0.36	4.80	50.7	1.5	7.92	32.7
0.50	5.68	60.0	2	10.56	38.9
0.80	7.16	75.6	3	15.84	49.0
1.1	8.45	89.2	4	21.12	58.0
1.4	9.61	101	5	26.40	65.5
1.8	10.7	113	6	31.68	73.0
2.1	11.7	124	7	36.96	80.5
2.5	12.6	133	8	42.24	86.0
2.8	13.5	143	9	47.52	92.5
3.1	14.2	150	10	52.80	97.2
3.9	15.9	168	12	63.36	109
4.8	17.5	185	14	73.92	120
5.5	18.8	198	16	84.48	128
6.3	20.1	212	18	95.04	137
7.1	21.4	226	20	105.60	146

FORTY-SIX-INCH PIPE.

Head in Feet required to produce Velocity.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	FRICTION HEAD in Feet		Discharge in Million Gallons per twenty-four Hours.
			Per 1,000 Feet	Per Mile	
0.02	1.04	12.0	0.10	0.53	7.78
0.02	1.16	13.4	0.12	0.64	8.68
0 03	1.31	15.1	0.15	0.79	9.76
0.04	1.55	17.8	0.2	1.06	11.5
0.06	1.96	22.6	0.3	1.58	14.6
0.08	2.30	26.5	0.4	2.11	17.1
0.11	2.62	30.2	0.5	2.64	19.6
0.13	2.90	33.5	0.6	3.17	21.7
0.16	3.18	36.7	0.7	3.70	23.8
0.18	3.42	39.5	0.8	4.22	25.6
0.21	3.67	42.3	0.9	4.75	27.3
0.24	3.89	44.9	1.0	5.28	29.1
0.37	4.91	56.7	1.5	7.92	36.6
0.53	5.82	67.2	2	10.56	43.6
0.84	7.37	85.0	3	15.84	55.0
1.2	8.70	100	4	21.12	64.8
1.5	9.90	114	5	26.40	73.9
1.9	11.0	127	6	31.68	82.1
2.2	12.0	138	7	36.96	90.7
2.6	12.9	149	8	42.24	96.5
3.0	13.8	159	9	47.52	103
3.3	14.6	168	10	52.80	109
4.1	16.3	188	12	63.36	121
5.0	17.9	207	14	73.92	133
5.8	19.3	223	16	84.48	144
6.7	20.7	239	18	95.04	154
7.5	22.0	254	20	105.60	164

FORTY-EIGHT-INCH PIPE.

Head in Feet required to produce Velocity	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	FRICTION HEAD in Feet		Discharge in Million Gallons per twenty-four Hours.
			Per 1,000 Feet	Per Mile	
0.02	1.07	13.4	0.10	0.53	8.68
0.02	1.18	14.8	0.12	0.64	9.59
0.03	1.35	17.0	0.15	0.79	11.0
0.04	1.60	20.1	0.2	1.06	13.0
0.06	2.02	25.4	0.3	1.58	16.4
0.09	2.37	29.8	0.4	2.11	19.4
0.11	2.69	33.8	0.5	2.64	21.8
0.14	2.97	37.3	0.6	3.17	24.2
0.16	3.26	41.0	0.7	3.70	26.6
0.19	3.52	44.2	0.8	4.22	28.7
0.22	3.78	47.5	0.9	4.75	30.8
0.25	4.00	50.3	1.0	5.28	32.7
0.40	5.05	63.5	1.5	7.92	41.1
0.56	5.98	75.2	2	10.56	48.6
0.89	7.56	95	3	15.84	61.5
1.2	8.90	112	4	21.12	72.5
1.6	10.2	128	5	26.40	86
2.0	11.3	142	6	31.68	92
2.4	12.4	156	7	36.96	101
2.8	13.3	167	8	42.24	108
3.1	14.2	178	9	47.52	115
3.5	15.0	188	10	52.80	121
4.3	16.7	210	12	63.36	136
5.3	18.4	231	14	73.92	149
6.1	19.8	249	16	84.48	161
7.1	21.3	267	18	95.04	173
7.9	22.6	284	20	105.60	184

FIFTY-FOUR-INCH PIPE.

Head in Feet required to produce Velocity.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	FRICTION HEAD in Feet		Discharge in Million Gallons per twenty-four Hours.
			Per 1,000 Feet	Per Mile	
0.02	1.14	18.1	0.10	0.53	11.7
0.03	1.27	20.2	0.12	0.64	13.1
0.03	1.44	22.9	0.15	0.79	14.6
0.05	1.73	27.5	0.2	1.06	17.7
0.07	2.16	34.3	0.3	1.58	22.2
0.10	2.51	39.9	0.4	2.11	25.7
0.13	2.86	45.5	0.5	2.64	29.5
0.16	3.18	50.5	0.6	3.17	32.7
0.19	3.47	55.2	0.7	3.70	35.7
0.22	3.75	59.6	0.8	4.22	38.5
0.25	4.00	63.6	0.9	4.75	41.1
0.28	4.23	67.3	1.0	5.28	43.6
0.45	5.38	85.4	1.5	7.92	55.3
0.63	6.36	101	2	10.56	65.5
1.0	8.05	128	3	15.84	82.9
1.4	9.50	151	4	21.12	98
1.8	10.8	172	5	26.40	111
2.3	12.1	192	6	31.68	124
2.7	13.2	210	7	36.96	136
3.1	14.2	225	8	42.24	145
3.5	15.1	240	9	47.52	155
4.0	16.0	254	10	52.80	164
5.0	17.9	284	12	63.36	184
6.0	19.6	311	14	73.92	202
7.0	21.2	337	16	84.48	218
8.0	22.7	361	18	95.04	234
9.1	24.2	384	20	105.60	248

SIXTY-INCH PIPE.

Head in Feet required to produce Velocity.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	FRICTION HEAD in Feet		Discharge in Million Gallons per twenty-four Hours.
			Per 1,000 Feet	Per Mile	
0.02	1.20	23.6	0.10	0.53	15.3
0.03	1.34	26.3	0.12	0.64	17.0
0.04	1.52	29.8	0.15	0.79	19.3
0.05	1.80	35.3	0.2	1.06	22.8
0.08	2.28	44.8	0.3	1.58	29.0
0.11	2.68	52.6	0.4	2.11	34.0
0.14	3.03	59.5	0.5	2 64	38.5
0.18	3.38	66.3	0.6	3.17	43.0
0.21	3.69	72.4	0.7	3.70	47.0
0.25	3.98	78.1	0.8	4.22	50.6
0.28	4.25	83.4	0.9	4.75	54.0
0.32	4.50	88.3	1.0	5.28	57.0
0.50	5.68	111	1.5	7.92	71.5
0.70	6.71	131	2	10.56	84.5
1.1	8.49	166	3	15.84	107
1.6	10.0	198	4	21.12	128
2.0	11.4	223	5	26.40	144
2.5	12.7	249	6	31.68	161
3.0	13.8	271	7	36.96	176
3.5	14.9	293	8	42.24	190
4.0	16.0	314	9	47.52	204
4.5	17.0	333	10	52.80	215
5.6	19.0	373	12	63.36	242
6.7	20 8	408	14	73.92	264
7.8	22.4	439	16	84.48	284
9	24.1	473	18	95.04	306
10	25.5	500	20	105.60	324

SIXTY-SIX-INCH PIPE.

Head in Feet required to produce Velocity.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	FRICTION HEAD in Feet		Discharge in Million Gallons per twenty-four Hours.
			Per 1,000 Feet	Per Mile	
0.02	1.26	29.9	0.10	0.53	19.0
0.03	1.40	33.3	0.12	0.64	21.6
0.04	1.60	38.0	0.15	0.79	24.6
0.06	1.89	44.9	0.2	1.06	29.1
0.09	2.39	56.8	0.3	1.58	36.7
0.12	2.81	66.8	0.4	2.11	43.2
0.16	3.19	75.8	0.5	2.64	49.1
0.19	3.54	84.1	0.6	3.17	54.5
0.23	3.88	92.2	0.7	3.70	59.7
0.27	4.18	99.3	0.8	4.22	64.2
0.31	4.46	106	0.9	4.75	68.8
0.35	4.72	112	1.0	5.28	72.7
0.56	6.00	142	1.5	7.92	92.1
0.77	7.05	167	2	10.56	108
1.2	8.95	212	3	15.84	137
1.7	10.5	249	4	21.12	161
2.2	12.0	285	5	26.40	184
2.8	13.5	320	6	31.68	207
3.3	14.6	347	7	36.96	225
3.8	15.7	373	8	42.24	242
4.4	16.8	399	9	47.52	257
4.9	17.8	423	10	52.80	273
6.2	20.0	475	12	63.36	308
7.4	21.8	518	14	73.92	335
8.7	23.6	560	16	84.48	362
9.9	25.2	598	18	95.04	387
11.2	26.9	639	20	105.60	414

SEVENTY-TWO-INCH PIPE

Head in Feet required to produce Velocity.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	FRICTION HEAD in Feet		Discharge in Million Gallons per twenty-four Hours.
			Per 1,000 Feet	Per Mile	
0.03	1.32	37.3	0.10	0.53	24.2
0.03	1.47	41.6	0.12	0.64	27.0
0.04	1.67	47.2	0.15	0.79	30.6
0.06	1.99	56.3	0.2	1.06	36.5
0.10	2.51	71.0	0.3	1.58	46.0
0.13	2.93	82.8	0.4	2.11	53.6
0.17	3.32	93.9	0.5	2.64	60.8
0.21	3.70	104	0.6	3.17	67.3
0.26	4.04	114	0.7	3.70	73.9
0.29	4.37	123	0.8	4.22	79.5
0.34	4.68	132	0.9	4.75	85.5
0.38	4.93	139	1.0	5.28	90
0.61	6.25	176	1.5	7.92	114
0.85	7.38	208	2	10.56	135
1.4	9.35	264	3	15.84	171
1.9	11.0	311	4	21.12	202
2.4	12.5	353	5	26.40	228
3.1	14.0	395	6	31.68	256
3.6	15.1	427	7	36.96	276
4.1	16.3	461	8	42.24	299
4.8	17.5	494	9	47.52	320
5.3	18.5	523	10	52.80	340
6.7	20.8	588	12	63.36	381
8 1	22.8	644	14	73.92	418
9.4	24.6	695	16	84.48	450
10.0	26.4	746	18	95.04	484
12.2	28	791	20	105.60	513

SEVENTY-EIGHT-INCH PIPE.

Head in Feet required to produce Velocity.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	FRICTION HEAD in Feet		Discharge in Million Gallons per twenty-four Hours.
			Per 1,000 Feet	Per Mile	
0.03	1.38	45.8	0.10	0.53	29.7
0.04	1.54	51.1	0.12	0.64	33.2
0.05	1.76	58.4	0.15	0.79	37.7
0.07	2.08	69.0	0.2	1.06	44.7
0.11	2.62	86.9	0.3	1.58	56.1
0.14	3.05	101	0.4	2.11	65.5
0.19	3.47	115	0.5	2.64	74.5
0.23	3.86	128	0.6	3.17	83.0
0.28	4.21	139	0.7	3.70	90.0
0.32	4.54	150	0.8	4.22	97.3
0.37	4.88	162	0.9	4.75	105
0.41	5.15	171	1.0	5.28	111
0.66	6.51	216	1.5	7.92	140
0.94	7.70	255	2	10.56	165
1.5	9.80	325	3	15.84	211
2.1	11.5	381	4	21.12	247
2.7	13.1	434	5	26.40	281
3.4	14.7	489	6	31.68	317
3.8	15.8	524	7	36.96	340
4.5	17.2	570	8	42.24	369
5.1	18.3	607	9	47.52	392
5.8	19.4	643	10	52.80	417
7.3	21.7	720	12	63.36	467
8.8	23.9	793	14	73.92	515
10.3	25.8	856	16	84.48	555
11.8	27.6	915	18	95.04	592
13.4	29.4	975	20	105.60	638

EIGHTY-FOUR-INCH PIPE.

Head in Feet required to produce Velocity.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	FRICTION HEAD in Feet		Discharge in Million Gallons per twenty-four Hours.
			Per 1,000 Feet	Per Mile	
0.04	1.44	55.4	0.10	0.53	35.9
0.04	1.60	61.6	0.12	0.64	40.0
0.05	1.82	70.0	0.15	0.79	45.4
0.08	2.16	83.1	0.2	1.06	53.9
0.12	2.73	105	0.3	1.58	68.0
0.16	3.20	123	0.4	2.11	79.5
0.21	3.63	139	0.5	2.64	90.0
0.26	4.03	155	0.6	3.17	100
0.30	4.40	169	0.7	3.70	109
0.35	4.75	182	0.8	4.22	118
0.40	5.10	196	0.9	4.75	127
0.45	5.38	207	1.0	5.28	134
0.72	6.82	262	1.5	7.92	170
1.0	8.05	309	2	10.56	200
1.7	10.0	385	3	15.84	249
2.3	12.0	461	4	21.12	298
3.0	13.7	529	5	26.40	343
3.7	15.3	588	6	31.68	381
4.4	16.6	639	7	36.96	413
5.1	18.0	692	8	42.24	448
5.8	19.2	738	9	47.54	477
6.4	20.3	781	10	52.80	508
8.0	22.7	873	12	63.36	565
9.6	24.8	954	14	73.92	620
11.1	26.8	1031	16	84.48	670
12.7	28.7	1104	18	95.04	715
14.3	30.4	1169	20	105.60	758

NINETY-INCH PIPE.

Head in Feet required to produce Velocity.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	FRICTION HEAD in Feet		Discharge in Million Gallons per twenty-four Hours.
			Per 1,000 Feet	Per Mile	
0.04	1.50	66.3	0.10	0.53	43.0
0.05	1.67	73.8	0.12	0.64	47.6
0.06	1.90	83.9	0.15	0.79	54.1
0.08	2.25	99.4	0.2	1.06	64.5
0.13	2.85	125	0.3	1.58	81.5
0.17	3.30	145	0.4	2.11	94.0
0.22	3.76	166	0.5	2.64	107
0.28	4.19	185	0.6	3.17	120
0.33	4.55	201	0.7	3.70	130
0.38	4.92	217	0.8	4.22	140
0.43	5.27	232	0.9	4.75	150
0.47	5.58	246	1.0	5.28	159
0.77	7.05	311	1.5	7.92	202
1.08	8.35	368	2	10.56	238
1.71	10.5	463	3	15.84	300
2.35	12.3	543	4	21.12	352
3.09	14.1	622	5	26.40	405
3.88	15.8	698	6	31.68	452
4.54	17.1	755	7	36.96	490
5.30	18.5	817	8	42.24	530
6.00	19.7	870	9	47.54	563
6.85	21.0	927	10	52.80	600
8.65	23.6	1042	12	63.36	678
10.3	25.8	1139	14	73.92	737
12.0	27.8	1228	16	84.48	797
13.7	29.8	1316	18	95.04	852
15.6	31.7	1410	20	105.60	915

NINETY-SIX-INCH PIPE.

Head in Feet required to produce Velocity.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	FRICTION HEAD in Feet		Discharge in Million Gallons per twenty-four Hours.
			Per 1,000 Feet	Per Mile	
0.04	1.56	78.4	0.10	0.53	50.7
0.05	1.73	86.9	0.12	0.64	56.1
0.06	1.97	99	0.15	0.79	69.5
0.09	2.32	116	0.2	1.06	75.2
0.14	2.95	148	0.3	1.58	96
0.19	3.45	173	0.4	2.11	112
0.24	3.93	197	0.5	2.64	127
0.30	4.38	220	0.6	3.17	142
0.36	4.78	240	0.7	3.70	155
0.42	5.18	260	0.8	4.22	168
0.47	5.50	276	0.9	4.75	179
0.53	5.83	293	1.0	5.28	190
0.85	7.40	371	1.5	7.92	241
1.2	8.75	439	2	10.56	285
1.9	11.0	552	3	15.84	357
2.7	13.0	653	4	21.12	425
3.4	14.8	743	5	26.40	482
4.3	16.6	834	6	31.68	540
5.0	18.0	904	7	36.96	586
5.9	19.5	980	8	42.24	635
6.7	20.8	1045	9	47.54	675
7.5	22.0	1105	10	52.80	715
9.4	24.6	1236	12	63.36	801
11.3	27.0	1357	14	73.92	875
13.1	29.0	1457	16	84.48	940
14.9	31.1	1563	18	95.04	1012
16.9	33.0	1658	20	105.60	1071

ONE HUNDRED AND EIGHT.

Head in Feet required to produce Velocity.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	FRICTION HEAD in Feet		Discharge in Million Gallons per twenty-four Hours.
			Per 1,000 Feet	Per Mile	
0.05	1.66	105	0.10	0.53	68.0
0.06	1.83	116	0.12	0.64	75.2
0.07	2.05	130	0.15	0.79	84.5
0.10	2.48	157	0.2	1.06	101
0.16	3.13	191	0.3	1.58	124
0.21	3.67	233	0.4	2.11	151
0.27	4.17	265	0.5	2.64	171
0.32	4.63	294	0.6	3.17	190
0.40	5.05	321	0.7	3.70	207
0.47	5.46	347	0.8	4.22	225
0.54	5.85	372	0.9	4.75	242
0.60	6.20	394	1.0	5.28	255
0.96	7.85	499	1.5	7.92	323
1.33	9.25	588	2	10.56	381
2.07	11.6	737	3	15.84	477
2.95	13.8	877	4	21.12	567
3.85	15.7	1002	5	26.40	650
4.85	17.7	1126	6	31.68	730
5.60	19.0	1208	7	36.96	783
6.60	20.6	1310	8	42.24	850
7.50	22.0	1399	9	47.52	905
8.40	23.2	1475	10	52.80	955
10.3	26.0	1660	12	63.36	1075
12.7	28.6	1819	14	73.92	1180
14.7	30.8	1959	16	84.48	1270
16.9	33.0	2099	18	95.04	1355
18.9	35.0	2226	20	105.60	1440

ONE HUNDRED AND TWENTY.

Head in Feet required to produce Velocity.	Velocity in Feet per Second.	Discharge in Cubic Feet per Second.	FRICTION HEAD in Feet		Discharge in Million Gallons per twenty-four Hours.
			Per 1,000 Feet	Per Mile	
0.05	1.75	137	0.10	0.53	89.0
0.06	1.95	153	0.12	0.64	99.0
0.07	2.12	166	0.15	0.79	107
0.11	2.63	206	0.2	1.06	133
0.18	3.32	260	0.3	1.58	168
0.25	3.95	310	0.4	2.11	201
0.32	4.48	340	0.5	2.64	221
0.39	4.98	391	0.6	3.17	253
0.47	5.46	428	0.7	3.70	277
0.54	5.87	461	0.8	4.22	299
0.62	6.29	494	0.9	4.75	320
0.69	6.65	522	1.0	5.28	338
1.09	8.42	661	1.5	7.92	429
1.53	9.92	779	2	10.56	505
2.43	12.5	981	3	15.84	637
3.38	14.7	1156	4	21.12	750
4.39	16.8	1319	5	26.40	850
5.47	18.8	1476	6	31.68	955
6.46	20.4	1602	7	36.96	1040
7.50	22.0	1727	8	42.24	1119
8.56	23.5	1845	9	47.52	1200
9.70	25.0	1963	10	52.80	1270
12.1	27.9	2120	12	63.36	1370
14.5	30.5	2295	14	73.92	1480
16.9	33.0	2591	16	84.48	1680
19.2	35.2	2764	18	95.04	1790
21.9	37.6	2953	20	105 60	1910

Diameter of Pipe in Inches.	Area in Square Feet.	Hydraulic Radius R in Feet.	$\sqrt{R}$ in Feet.	Discharge in Million Gallons per Twenty-four Hours with Velocity of 1 Foot per Second.
10	0.5454	0.2083	0.456	0.352
12	0.7854	0.2500	0.500	0.508
14	1.069	0.2917	0.540	0.691
16	1.396	0.3333	0.577	0.902
18	1.767	0.3750	0.612	1.14
20	2.182	0.4167	0.646	1.41
22	2.640	0.4583	0.677	1.71
24	3.142	0.5000	0.707	2.03
26	3.637	0.5417	0.736	2.38
28	4.276	0.5833	0.764	2.76
30	4.909	0.6250	0.790	3.17
32	5.585	0.6667	0.817	3.61
34	6.305	0.7083	0.842	4.07
36	7.069	0.7500	0.866	4.57
38	7.876	0.7917	0.890	5.09
40	8.727	0.8333	0.913	5.64
42	9.621	0.8750	0.935	6.22
44	10.56	0.9167	0.957	6.82
46	11.54	0.9583	0.979	7.46
48	12.57	1.0000	1.000	8.12
54	15.90	1.1250	1.061	10.28
60	19.63	1.2500	1.118	12.69
66	23.76	1.3750	1.173	15.35
72	28.27	1.5000	1.225	18.27
78	33.18	1.6250	1.275	21.44
84	38.48	1.7500	1.323	24.87
90	44.18	1.8750	1.369	28.55
96	50.26	2.0000	1.414	32.48
108	63.62	2.2500	1.500	41.12
120	78.54	2.5000	1.581	50.76

VALUES OF C IN KUTTER'S FORMULA

with n = 0.010.

Fall in Feet per 1,000 Ft.	Diameter of Pipe in Inches.									
	10	12	14	16	18	20	22	24	26	28
0.10	99	104	109	113	117	120	123	126	129	131
0.12	101	107	112	116	120	123	126	128	131	133
0.15	104	109	113	117	121	124	127	130	132	134
0.2	107	112	116	120	123	127	130	132	134	137
0.3	110	115	118	123	126	130	133	135	137	139
0.4	111	116	120	124	127	131	134	136	137	140
0.5	112	118	122	126	129	132	135	137	139	141
0.6	113	118	123	126	129	132	135	137	139	142
0.7	113	118	123	126	129	132	135	137	139	142
0.8	114	119	123	126	129	132	135	137	140	142
0.9	114	119	123	126	129	132	135	137	140	142
1.0	114	119	123	126	129	132	135	137	140	142
1.5	115	120	124	127	130	133	136	138	141	143
2	115	121	124	127	130	133	136	139	141	144
3	116	121	124	128	131	134	136	140	141	144
4	116	121	125	129	132	135	137	140	142	144
5	116	121	125	129	132	135	137	140	142	144
6	116	121	125	129	132	135	137	140	142	144
7	116	121	125	129	132	135	137	140	142	144
8	116	121	125	129	132	135	137	140	142	144
9	116	121	125	129	132	135	137	140	142	144
10	116	121	125	129	132	135	137	140	142	144
12	116	121	125	129	132	135	137	140	142	144
14	116	121	125	129	132	135	137	140	142	144
16	116	121	125	129	132	135	137	140	142	144
18	116	121	125	129	132	135	137	140	142	144
20	116	121	125	129	132	135	137	140	142	144

VALUES OF C IN KUTTER'S FORMULA

with n = 0.010.

Fall in Feet per 1,000 Ft.	Diameter of Pipe in Inches.									
	30	32	34	36	38	40	42	44	46	48
0.10	133	135	137	139	140	142	143	145	146	147
0.12	135	137	139	141	143	144	145	147	148	149
0.15	136	138	140	142	143	144	146	147	149	150
0.2	138	140	142	143	145	147	148	149	151	152
0.3	141	142	144	146	148	149	150	152	153	154
0.4	142	143	145	146	148	149	151	152	154	154
0.5	143	145	146	148	149	150	152	153	154	155
0.6	143	145	146	148	149	151	152	153	154	155
0.7	143	145	146	148	149	151	152	153	154	155
0.8	143	145	146	148	149	151	152	153	154	155
0.9	143	145	146	148	149	151	152	153	154	155
1.0	143	145	146	148	149	151	152	153	154	155
1.5	144	146	147	149	150	152	153	154	155	156
2	144	146	147	149	150	152	153	154	155	156
3	145	147	148	149	151	152	153	154	155	156
4	145	147	149	150	152	153	154	155	156	157
5	145	147	149	150	152	153	154	155	156	157
6	145	147	149	150	152	153	154	155	156	157
7	145	147	149	150	152	153	154	155	156	157
8	145	147	149	150	152	153	154	155	156	157
9	145	147	149	150	152	153	154	155	156	157
10	145	147	149	150	152	153	154	155	156	157
12	145	147	149	150	152	153	154	155	156	157
14	145	147	149	150	152	153	154	155	156	157
16	145	147	149	150	152	153	154	155	156	157
18	145	147	149	150	152	153	154	155	156	157
20	145	147	149	150	152	153	154	155	156	157

VALUES OF C IN KUTTER'S FORMULA

with $n = 0.010$.

Fall in Feet per 1,000 Ft.	Diameter of Pipe in Inches.								
	54	60	66	72	78	84	96	108	120
0 10	151	154	157	160	162	164	168	171	174
0 12	153	156	159	161	163	165	169	172	174
0.15	154	156	159	161	163	165	169	172	174
0.2	155	158	160	162	165	167	170	172	175
0.3	157	159	162	163	166	167	170	173	175
0 4	157	160	162	164	166	168	170	173	175
0 5	158	161	162	165	167	168	171	173	175
0 6	158	161	163	165	167	168	171	173	175
0 7	158	161	163	165	167	168	171	173	175
0 8	158	161	163	165	167	168	171	173	175
0 9	158	161	163	165	167	168	171	173	175
1 0	158	161	163	165	167	168	171	173	175
1 5	159	161	163	165	167	168	171	173	175
2	159	161	164	166	167	168	171	173	175
3	159	162	164	166	167	169	171	173	175
4	159	162	164	166	167	169	171	174	175
5	159	162	164	166	167	169	171	174	175
6	159	162	164	166	167	169	171	174	175
7	159	162	164	166	167	169	171	174	175
8	159	162	164	166	167	169	171	174	175
9	159	162	164	166	167	169	171	174	175
10	159	162	164	166	167	169	171	174	175
12	159	162	164	166	167	169	171	174	175
14	159	162	164	166	167	169	171	174	175
16	159	162	164	166	167	169	171	174	175
18	159	162	164	166	167	169	171	174	175
20	159	162	164	166	167	169	171	174	175

PRESSURE OF WATER.

Head in Feet.	Pressure in Lbs. per Sq. Inch.	Head in Feet.	Pressure in Lbs. per Sq. Inch.	Head in Feet.	Pressure in Lbs. per Sq. Inch.	Head in Feet.	Pressure in Lbs. per Sq. Inch.	Head in Feet.	Pressure in Lbs. per Sq. Inch.	Head in Feet.	Pressure in Lbs. per Sq. Inch.
1	0.4	51	22.1	101	43.7	151	65.4	201	87.1	251	108.7
2	0.9	52	22.5	102	44.2	152	65.8	202	87.5	252	109.2
3	1.3	53	22.9	103	44.6	153	66.3	203	87.9	253	109.6
4	1.7	54	23.4	104	45.0	154	66.7	204	88.4	254	110.0
5	2.2	55	23.8	105	45.5	155	67.1	205	88.8	255	110.5
6	2.6	56	24.3	106	45.9	156	67.6	206	89.2	256	110.9
7	3.0	57	24.7	107	46.3	157	68.0	207	89.7	257	111.3
8	3.5	58	25.1	108	46.8	158	68.4	208	90.1	258	111.8
9	3.9	59	25.5	109	47.2	159	68.9	209	90.5	259	112.2
10	4.3	60	26.0	110	47.6	160	69.3	210	91.0	260	112.6
11	4.8	61	26.4	111	48.1	161	69.7	211	91.4	261	113.1
12	5.2	62	26.8	112	48.5	162	70.2	212	91.8	262	113.5
13	5.6	63	27.3	113	48.9	163	70.6	213	92.3	263	113.9
14	6.1	64	27.7	114	49.4	164	71.0	214	92.7	264	114.4
15	6.5	65	28.1	115	49.8	165	71.5	215	93.1	265	114.8
16	6.9	66	28.6	116	50.2	166	71.9	216	93.6	266	115.2
17	7.4	67	29.0	117	50.7	167	72.3	217	94.0	267	115.7
18	7.8	68	29.4	118	51.1	168	72.8	218	94.4	268	116.1
19	8.2	69	29.9	119	51.5	169	73.2	219	94.9	269	116.5
20	8.7	70	30.3	120	52.0	170	73.6	220	95.3	270	117.0
21	9.1	71	30.7	121	52.4	171	74.1	221	95.7	271	117.4
22	9.5	72	31.2	122	52.8	172	74.5	222	96.2	272	117.8
23	10.0	73	31.6	123	53.3	173	74.9	223	96.6	273	118.3
24	10.4	74	32.0	124	53.7	174	75.4	224	97.0	274	118.7
25	10.8	75	32.5	125	54.1	175	75.8	225	97.5	275	119.1
26	11.3	76	32.9	126	54.6	176	76.2	226	97.9	276	119.6
27	11.7	77	33.3	127	55.0	177	76.7	227	98.3	277	120.0
28	12.1	78	33.8	128	55.4	178	77.1	228	98.8	278	120.4
29	12.5	79	34.2	129	55.9	179	77.5	229	99.2	279	120.8
30	13.0	80	34.6	130	56.3	180	78.0	230	99.6	280	121.3
31	13.4	81	35.1	131	56.7	181	78.4	231	100.1	281	121.7
32	13.9	82	35.5	132	57.2	182	78.8	232	100.5	282	122.1
33	14.3	83	35.9	133	57.6	183	79.3	233	100.9	283	122.6
34	14.7	84	36.4	134	58.0	184	79.7	234	101.4	284	123.0
35	15.2	85	36.8	135	58.5	185	80.1	235	101.8	285	123.4
36	15.6	86	37.2	136	58.9	186	80.6	236	102.2	286	123.9
37	16.0	87	37.7	137	59.3	187	81.0	237	102.7	287	124.3
38	16.5	88	38.1	138	59.8	188	81.4	238	103.1	288	124.7
39	16.9	89	38.5	139	60.2	189	81.9	239	103.5	289	125.2
40	17.3	90	39.0	140	60.6	190	82.3	240	104.0	290	125.6
41	17.7	91	39.4	141	61.1	191	82.7	241	104.4	291	126.0
42	18.2	92	39.8	142	61.5	192	83.2	242	104.8	292	126.5
43	18.6	93	40.3	143	61.9	193	83.6	243	105.3	293	126.9
44	19.0	94	40.7	144	62.4	194	84.0	244	105.7	294	127.3
45	19.5	95	41.1	145	62.8	195	84.5	245	106.1	295	127.8
46	19.9	96	41.6	146	63.2	196	84.9	246	106.6	296	128.2
47	20.3	97	42.0	147	63.7	197	85.3	247	107.0	297	128.6
48	20.8	98	42.4	148	64.1	198	85.8	248	107.4	298	129.1
49	21.2	99	42.9	149	64.5	199	86.2	249	107.9	299	129.5
50	21.6	100	43.3	150	65.0	200	86.6	250	108.3	300	129.9

HYDRAULIC WEIGHTS AND MEASURES.

1 U. S. Gallon	=231 Cubic Inches.
1 Cubic Foot	=7.48 U. S. Gallons.
1 Acre-Foot	=43,560 Cubic Feet.
1 Acre-Foot	=325,829 U. S. Gallons.
1 Square Mile-Inch	=53.33 Acre-Feet.
1 Square Mile-Inch	=2,323,200 Cubic Feet.
1 Square Mile-Inch	=17,377.536 U. S. Gallons.
1 Cubic Foot per Second	=646,272 U. S. Gals. per day (24 hrs.)
1 Cubic Foot per Second	=50 California Miners' Inches.
1 Cubic Foot per Second	=38.4 Colorado Miner's Inches.
1 California Miner's Inch	=0.020 Cubic Feet per Second.
1 Colorado Miner's Inch	=0.026 Cubic Feet per Second.
1 Million U. S. Gallons per Day	=1.55 Cubic Feet per Second.
1 Foot of Depth	=0.433472 Pounds per Square Inch.
1 Pound Per Square Inch	=2.307 Feet of Water.
1 Inch of Mercury at 32°	=1.1334 Feet of Water.
1 Atmosphere (equals 29.992 Inches Mercury) .	=33.9 Feet of Water.
1 Cubic Foot of Water per Second falling 1 ft. vertical	=0.1135 Horse Power (theoretical).

1 Cubic Foot of Water at 39.2° F. weighs 62.4 Pounds.
1 U. S. Gallon of Water at 39.2° weighs 8.34 Pounds.