TECHNICAL INFORMATION
Bulletin

NUMBER 101

HYDRO-PNEUMATIC PRESSURE SYSTEMS

FOREWORD

It is possible to buy complete hydro-pneumatic pressure systems which incorporate deep well reciprocating, jet or shallow well pumps for ¼ HP up to 3 HP in size. On these units the designs are well balanced for average household service and little engineering is necessary. However the optimum design of a larger hydro-pneumatic pressure system for use with a deep well or large horizontal pump on a given application presents a complex engineering problem.

In order to secure the greatest usefulness of the unit combined with the least operating cost per gallon of water used, a selection of the size of pump, size of tank, maximum and minimum percentages of the tank to contain air and the desired control fittings must be based and made on their known relationships to each other. There is no reference work available to the customer or

field engineer which will give him a detailed and thorough summary of the interrelationships required of the above mentioned components for every application in general.

Peerless dealers and salesmen have frequently requested the Engineering Department to give them a complete explanation of how to select the proper equipment for large hydro-pneumatic pressure installations. For many years our Engineering Department has been collecting data concerning this subject. Considerable time and effort has been spent in organizing and correlating this information. The treatment of the subject represents a practical approach to the problem. The information is compiled in a concise manner and is documented with working charts, tables and drawings to facilitate the solution of actual everyday problems in relation to every type of hydro-pneumatic pressure system.

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I. GENERAL DESCRIPTION

The hydro-pneumatic pressure system is a modernization of the older gravity tank method of water supply. Its main purpose is to control or boost a limited supply pressure to a higher or more uniform value so that a continuous and satisfactory water supply will be available at all fixtures within the system.

The fundamentals of a system which accomplishes this purpose consist of a suitable pump, a pressure tank and essential control devices for making the system operate automatically with the least amount of supervision. The pump is used for supplying the required amount of water into the tank at the proper pressure while the tank acts as a storage vessel for the proper ratios of water and air within the pressures and levels maintained by the control devices.

The expansion of air under reducing pressures regulates the amount of water which can be used by the system before the pump is again called upon to replenish the reserve that is desired to be maintained in the tank. This pressure and volume relationship is a well known law of physics which states that at constant temperature the volume of a given weight of gas varies inversely as the absolute pressure. It is known as Boyle's law and is expressed mathematically as follows:

$$\frac{P1}{P2} = \frac{V2}{V1}$$

The curve charts for determining the best limits of operating pressure and the best high water level in the tank are compiled from this formula.

Hydro-pneumatic pressure units have definite advantages over gravity tanks. They are generally placed in a location that is convenient for installation, service or repairs; generally sheltered against damage from the elements; the system is completely enclosed and when properly filtered

air is used to replenish that used up in the tank there will be complete isolation from possible contamination.

There are four general types of hydro-pneumatic pressure systems: (1) the domestic type, (2) the deep well pump type, (3) the booster type and (4) the combination type which consists of a deep well pump which in turn supplies a booster type system. Another, (5) known as the tankless or cushion tank type system, is not a true hydro-pneumatic pressure system although it relies on the functioning of a relatively small pneumatic cushion tank for its successful operation. All hydro-pneumatic pressure systems function in a similar manner and differ only in the utilization of the pumps and controls which are necessary to fulfill the system requirements.

Shallow Well Domestic Type
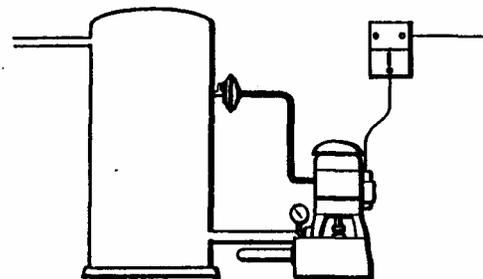
(1) The domestic type systems are used for installations where relatively small water and pressure requirements are demanded. They are generally small enough to be constructed in a compact, integral unit although some systems utilize separately installed pressure tanks. Almost all kinds of pumps are used with this type of unit; centrifugal, jet, turbine, helical rotor and reciprocating. Air is generally supplied to the pressure tank by means of a snifter valve connected to the suction side of the pump.

Deep Well Type Pump
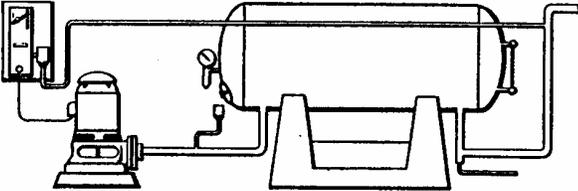
(2) The proved capacity of a deep well must he considered before attempting to select the appropriate type of deep well hydro-pneumatic pressure system. If the water is taken from an existing well which has a proved capacity sufficient to meet the demands of the system, a simple deep well pump type of installation is indicated, but if the well supply is insufficient to meet the demands of the system, or if the water is contaminated with natural gases, a combination type system is required. New wells should always be tested for capacity and quality before the type of hydro-pneumatic pressure system is selected and specified.

A simple deep well pump type of installation is used when the water supply is taken from a clear deep well which has sufficient capacity to meet the demands of the system. All ranges of capacities and pressures can be met by this type of system and any desired kind of deep well pump can be used. Air can be supplied to the pressure tank by three different methods: by draining a portion of the discharge line and then forcing the entrapped air into the tank during each pump cycle, by utilizing the tank pressure for operating an air displacement compressor, like the Nu-Matic Control, or by using a separate standard air compressor.

Booster Type
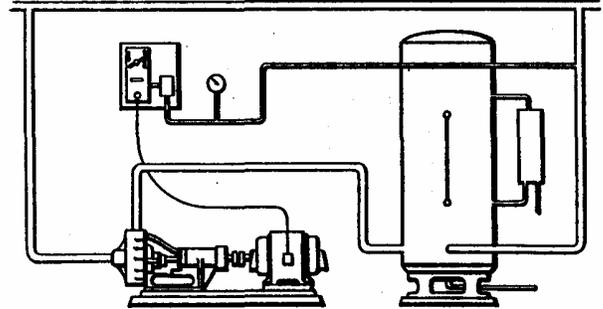
(3) A booster type hydro-pneumatic pressure system is called for when the water pressure in a city supply periodically fluctuates below a uniform usable value or when the supply is taken from a separate storage basin or reservoir. All kinds and types of centrifugal pumps can be used in this service. Air is generally supplied to the pressure tank by means of a displacement type compressor or standard air compressor.

Combination Type
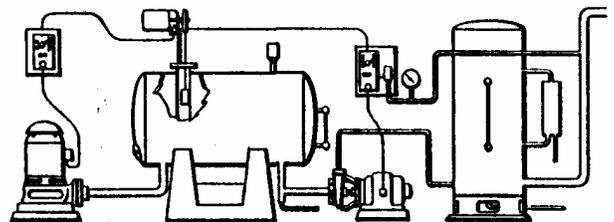
(4) A combination type hydro-pneumatic pressure system is required when the deep well water supply is insufficient to meet the direct demands of the installation or when it is contaminated, by gases. In this arrangement the deep well pump is controlled to operate as needed for building up a reserve capacity in a vented tank or reservoir from which the booster pump (with a capacity sufficient to meet the demands of the system) takes its supply and fulfills the requirements of the pressure tank. The booster pump should be controlled so that draws from its reservoir only when there is sufficient pumping capacity available.

The reservoir should be selected so that its working capacity is approximately sufficient to take care of the period of peak demand on the system but in no case should its capacity be less than twice the working differential volume of the pressure tank. It should be remembered that the working capacity of the pressure tank is generally a fraction of its total capacity while practically the entire volume of the reservoir can be utilized.

The same precautions must be used in the construction of the reservoir as are used with the pressure tank for protecting the purity of the water. If the well water is gaseous, it is advisable to vent off the gas so that it does not remain in contact with or affect the potability of the water. The vent should be piped to a safe area for exhaust and if this line is also used as a "breather" while the water in the reservoir is being pumped down, a suitable air filter should be fitted to the end of the pipe.

The operation of the deep well pump is controlled by a float switch or similar device which is installed in the reservoir while the booster pump is operated by the controls installed in the pressure tank. The control circuits should be interconnected so that the booster pump will remain or become inoperative while there is insufficient water in reserve in the reservoir.

It is evident that the deep well pump switch should open the circuit (stop the pump) at the H.W.L. to be maintained in the reservoir and again close the circuit (start the pump) at a predetermined L.W.L. The L.W.L. should be selected so that for small ratios of pump capacity/system demand, the deep well pump will be made to operate at a higher water level than when this ratio is of greater magnitude.

Cushion Tank Type
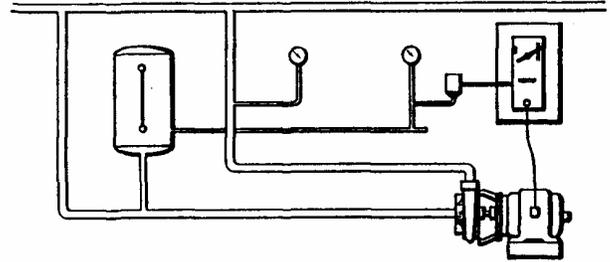
(5) The tankless or cushion tank type of system is generally used with small installations when the water supply is taken from a city supply and the pressure drops below a uniform, usable value only at irregular intervals or for relatively short periods of time. The cushion tank can be relatively small; generally not over 20 gallons total capacity and sufficient only to take care of minor withdrawals without too frequent starting of the pump.

The setting of the controls may best be explained by an example: The normal city pressure is 55 P.S.I. and drops to 45 P.S.I. with ordinary building use. The minimum pressure required by the system is 25 PSI. Setting the pressure switch to cut in at 25 P.S.I. and cutout at 40 P.S.I. will maintain the minimum pressure requirements of the system and allow the pump to cut out at a suitable value when the city pressure is again sufficiently restored. If periodical, frequent starts and stops are anticipated it is suggested that the thermal protection units in the starter be selected to compensate for the service demanded.

An air type tank valve, through which air can be pumped manually, must be installed in the pipe line between the cushion tank and the pressure switch. A tire pump is used at this valve to replenish the air in the tank. The air volume in the tank should be established similarly to that in a true hydro-pneumatic system so that air will not be forced into the system between pumping cycles.

The cushion tank type of system is the least expensive when initial installation cost is considered but it requires more supervision to maintain in a satisfactory operating condition and is also the least satisfactory when frequency of pumping cycles is high.

Design Considerations

Experience indicates that there are many hydro-pneumatic pressure systems now in operation which are working under adverse conditions because no thought had been given to the possibility of increased system demand occasioned by future expansion. Almost all public utility services, especially water supply, are constructed with primary consideration being given to future expansion, but for some reason, the same thought has not been extended to the pressure systems which are practically an extension of the primary service. May we suggest that serious consideration be given to the possible future requirements when a new hydro-pneumatic pressure system is being engineered. This suggestion becomes especially important when the water supply is taken from a deep well because the capacities of both the well and the pump must then be considered. Most of the existing unsatisfactory deep well pump systems can be made into satisfactorily operating installations by converting them into combination type systems.

II. DETERMINATIONS

Determination of Pump Capacities

The two common methods used to determine the proper capacity of the pump for a hydro-pneumatic pressure system are, (1) by recording meter, and (2) by estimation through the use of factors.

The first method is accurate and is popularly used for existing installations where a recording meter record (covering an extended period of time) can be obtained to determine the total water consumption as well as the maximum capacity at periods of peak demand. From this record, a pump which will have sufficient capacity to meet the maximum requirements of the system can be accurately selected. If the periods of peak demand extend over a comparatively great length of time, it is advisable to select a pump having a capacity of 125% to 150% more than the maximum demand. This is to provide sufficient water for replenishing the tank storage capacity at the same time that domestic requirements are being fulfilled.

The second method is by approximation. It is used only for new installations or where metering is not practicable. This method is based on an estimate of approximate consumption at peak demand periods, which in turn is based on records of similar installations. In the following Water Consumption Factor Tables, the actual use of the various plumbing fixtures has been disregarded and each fixture is considered merely as a unit. In this way, a factor method can be established which greatly simplifies the selection of a pump with sufficient capacity to meet satisfactorily the maximum or peak water consumption requirements of a given system.

The tables below are based on the factor method and have been calculated for direct use without additional corrections.

Water Consumption Factor Tables

In using these tables, the exact number of fixtures of all kinds to be supplied by the water system must be determined. This figure, when multiplied by the proper factor designated in the tables, will give the desired pump capacity in g.p.m.

Public Buildings-Factors in G.P.M. per Fixture

Kind of Building	Number of Fixtures						
	Up to 30	31-75	76-150	151-300	301-600	601-1000	Over 1000
Apartment Buildings, Apartment Hotels....	0.55	0.41	0.33	0.28	0.25	0.24	0.23
Commercial Hotels, Clubs................	0.80	0.60	0.48	0.42	0.36	0.35	0.34
Hospitals	0.90	0.76	0.63	0.54	0.45	0.40	0.38
Office Buildings	1.00	0.80	0.65	0.55	0.45	0.35	0.27
Schools	1.20	0.90	0.75	0.63	0.52	...	...
Mercantile Buildings	1.20	0.96	0.78	0.66	0.54	0.48	0.46

Rural Residences

Number of Fixtures	Factor-In G.P.M. per Fixture*
Up to 5	2.0
6-10	1.7
11-18	1.4
Over 18	1.2

* These factors are based on the assumption that moderate water requirements for stock, poultry and sprinkling are provided for at other than peak demand periods for domestic consumption. If it is anticipated that heavy demands for stock, poultry and sprinkling are essential, especially during peak demand periods for domestic use, then corrections for the added pump capacity may be made by referring to the tables for water requirements and water consumption. The successful water system is one in which the pump capacity is slightly in excess of the rate of water consumption during periods of peak demand.

Auxiliary Requirements

(1) 20% should be added to the pump capacity for all buildings in which the greater portion of occupants are women.

(2) When swimming pools or laundries are to be supplied through the pressure system, 10% should be added to the pump capacity for each facility.

(3) When an extra supply of water is used for process or special requirements, at least twice the average amount needed should be added to the pump capacity to take care of peak demand.

Water Requirements
Based on draft of various fixtures

Kitchen sink..........................	5 G.P.M. per outlet
Bath tubs...............	5 G.P.M. per outlet, or 30 Gal. per tub
Shower..........	5 G.P.M. per outlet, or 30 Gal. per bath (av.)
Toilet—Tank type...................	6 Gal. working capacity
	(2 Minutes Minimum)
Toilet—Valve type	3 Gal. working capacity
Urinal—Steady flow.....................	Approx. 1 G.P.M.
Urinal—Push valve.....................	Approx. ½ G.P.M.
Urinal—Time valve.....................	Approx. ½ G.P.M.
Lavatory—Free flow	5 G.P.M. per outlet
Lavatory—Spring closing...............	¼ G.P.M. per outlet
Laundry tub...........................	5 G.P.M. per outlet
Continuous drinking fountain...................	1½ G.P.M.
Garden hose—½″ with nozzle.................	3½ G.P.M.
Garden hose—¾″ with nozzle...................	5 G.P.M.
Lawn sprinkler...............................	2 G.P.M.

Park or golf course sprinkler; covering 106 foot diameter area with ¼″ main nozzle operating at 50 lb. pressure at nozzle .... 16 G.P.M.

Overhead irrigation system with 30-40 lb. nozzle pressure, equivalent to 1″ rainfall in 9 hrs. at 30 lbs.
Approx. 60 G.P.M. per acre

Water Consumption

	Gals. Per Day
Human (all fixtures).....	30-50
Horse	10
Steer	10
Cow (dry).............	10
Cow (fresh)	15-20
Hog	5
Sheep	3
Chickens (flock of 100)...	4
Turkeys (flock of 100)....	5
Ducks (flock of 100).....	5
Geese (flock of 100).....	7

Determination of Pump Pressures

Description of Procedure

The pressure requirements of a hydro-pneumatic pressure system are determined by this summation:

1. Static head, or vertical distance, in feet, from source of supply to highest fixture.

2. Friction, or head loss, in feet, through the pipe line, including losses in Suction and discharge piping, valves and fittings. (See tables and chart, Pages 28, 29 and 30.)

3. Minimum pressure requirement at the highest fixture (usually ten pounds per square inch). If the highest fixture is a flush valve or other device that requires greater pressure for proper operation, the higher pressure value should be used.

4. Pressure differential desired, (usually 20 pounds per square inch although greater differentials may contribute to higher system efficiency and should be checked to determine the best accepted value).

5. Suction pressure. When the pump takes suction under pressure, the minimum suction pressure available should be deducted from the calculated pressure requirements.

6. Fire protection. When the system is to be used for fire protection, it is desirable to maintain a minimum pressure of 40 P.S.I. at the tank, even when the calculations indicate that a lower pressure is adequate for domestic requirements.

Note: (1) Head, in feet, times 0.433 equals pressure in pounds per square inch.
        (2) Pressure, in pounds per square inch, times 2.31 equals head in feet.

Example

Determine the requirements for installing a Hydro-Pneumatic Pressure System in the basement of a high school. The source of supply is a deep well located adjacent to the school building.

The water for a total of 50 fixtures of all kinds and a swimming pool is to be supplied by the system. The static head from the pressure tank to the highest fixture is 42 feet and the frictional head loss through the piping is 16 feet. The total dynamic head from the water level in the well to the tank is 105 feet. The minimum pressure required at the highest fixture is 10 pounds per square inch and the desired operating differential for the system 20 pounds per square inch.

Solution
To determine pump capacity:

    50 x 0.90 (factor from table)………...45 G.P.M.
    10% for extra capacity to supply
        swimming pool (1.10 x 45)……49.5 G.P.M.

To determine maximum working pressure in the tank:

1. Static head (tank to highest fixture)……...42 feet
2. Frictional head loss in pressure system…16 feet
3. Minimum pressure at highest fixture
        (2.31 x 10)………………………….23.1 feet
4. Differential operating pressure
        (2.31 x 20)…………………….…..46.2feet
    Total working pressure in tank……...127.3 feet
    Converting (to pressure in P.S.I.)
        (0.433 x 127.3)…………………35.12 P.S.I.

Commercial pressure switches are usually stocked for set operating values so, to simplify our problem, we will select one which will most nearly meet our selected conditions. Therefore, the pressure switch should be ordered so as to operate on a 20 P.S.I. Differential: that is, to cut in at 40 P.S.I. and to cut out at 60 P.S.I.

For pump selection:

(a) Maximum working pressure in the
tank (2.31 x 60)………………………..138.6
(b) Total dynamic head (water level
in well to tank)………………………….105.0
(c) Total head required for the pump…………243.6
(d) Rounding off the above established figures, it is now only necessary to choose an appropriate deep well type pump that will produce a minimum of 50 gallons per minute when pumping against a minimum total head of 245 feet.

DETERMINATION OF TANK WORKING PRESSURES AND WATER LEVELS

Selecting Pressure Differential

Selecting the best operating pressure differential, the control levels in the tank, the pumping differential and the tank efficiency can readily be accomplished by the use of curves 2600536 and 2600463.

THE LOW WATER LEVEL (LWL) is the low level established in the tank at the lowest pressure under which the system is designed to operate. Ordinarily the LWL is established so that not less than 10% of the total tank capacity will be available for reserve below the low system pressure or for the variations inherent in the control instruments. This minimum reserve is determined by the volume available over the tank outlet connection so that the possibility of air loss into the piping system will be minimized.

THE HIGH WATER LEVEL (HWL) is the high level established in the tank at the highest pressure under which the system is designed to operate.

In our original problem we arbitrarily selected an operating pressure differential of 20 P.S.I. We will now indicate how to determine the desired HWL, the pumping volume differential, the

tank efficiency and whether the 20 P.S.I. pressure differential is the most desirable for our application.

Refer to curve 2600536. Start at the point indicating a reserve of 10 percent by volume in the tank and follow this line horizontally to where it intersects the vertical 40 P.S.I. pressure line. Follow the closest pressure curve (in this case the 33 P.S.I. curve) to where it intersects the vertical 60 P.S.I. line. Then by interpolation determine the point which indicates that the water will occupy approximately 34% of the total tank capacity when the air has been compressed from 40 P.S.I. to 60 P.S.I. The water level equivalent to 34% of the tank volume establishes the desired HWL.

The pumping differential is the difference in volume between the HWL and LWL in the tank. This differential expressed in percent also indicates the tank efficiency. Thus, 34% minus 10% indicates that the pumping differential is 24% of the total tank volume. With 24% of the total tank volume available for pumping, the tank efficiency also is 24%.

The actual HWL and LWL in the tank may now be established. The volume in a cylindrical, vertical tank is proportional to the height. Assume that a vertical tank is 72 inches high and the tank discharge is located in the tank bottom. Then the LWL is 10/100 x 72 or 7.2 inches above the bottom of the tank and the HWL is 34/100 x 72 or 24.48 inches above the bottom of the tank.

The volume in a cylindrical, horizontal tank is not proportional to the diameter (height) so we refer to curve 2600463 for converting percent of capacity to percent of diameter. Thus, 10 percent of the tank capacity is equivalent to approximately 15.7 percent of the diameter and 34% of capacity is equivalent to approximately 37.4 percent of diameter. Assume that a horizontal tank is 72

inches in diameter. Then the LWL is 15.7/100 x 72 or 11.3 inches above the bottom and the HWL is 37.4/100 x 72 or 26.9 inches above the bottom.

To summarize, we have now established how to determine the LWL, the HWL, the pumping differential and the tank efficiency. The remaining consideration is for determining the most desirable operating pressure differential.

Assume, for example, that the pressure differential is to be 30 P.S.I. with 40 P.S.I. at LWL and 70 P.S.I. at 1-IWL. Proceed as described above and determine that at 70 P.S.I. the water will occupy approximately 42% of the total tank volume. The pumping differential is 32% of the total tank volume and the tank efficiency is also 32%. This is a gain of 8 points over the 40-60 P.S.I. pressure selection. The pumping differential governs the size of the tank which will be required and also may affect the size of the pump and its driver because of the range in the pressure differential. It is desirable to evaluate the costs of each arrangement to determine the most efficient system.

DETERMINATION OF TANK CAPACITY AND SIZE

The size of the tank is governed by both the established pumping volume differential and the number of pumping cycles desired. Experience indicates that the average number of pumping cycles need never be greater than six and very seldom is it necessary to provide for fewer than four cycles per hour.

The greater the number of pumping cycles, the smaller will be the size of the required tank. This must be given serious consideration when the first cost of an installation is of prime importance. Fewer cycles will require the use of a larger tank but sometimes other important considerations besides first cost assume greater importance. Fewer pumping cycles are recommended for installations in hospitals, sanitariums, hotels, etc., where frequent starting and stopping may be annoying. Also when greater reserve is desired or required as, for example, when the installation is used for fire protection.

For example, to determine the tank size let us return to our original problem where the required pump capacity has been determined at 50 G.P.M., the pumping differential is 24 percent of the total tank capacity and that six pumping cycles per hour are desired.

Refer to curve 2600557 (page 10). This curve is based on the assumption that the average system demand is equivalent to one-half of the pump capacity. So with a pumping differential of 24 percent we determine from the curve for six pumping cycles per hour that the multiplication factor is 10.5x50 = 525 gallons or the total volume for the required tank. Refer to drawings 2800693 and 2800695 which list Peerless Standard Tanks in the Horizontal and Vertical Types, respectively. The nearest standard tank listed is a horizontal type 36 inches in diameter and 120 inches long which has a total volume of approximately 550 gallons.

PRESSURE AND VOLUME DIFFERENTIALS
FOR HYDRO-PNEUMATIC TANKS

VOLUME OF AIR IN TANK—IN PERCENT OF TOTAL VOLUME

PRESSURE IN TANK—IN POUNDS PER SQUARE INCH—GAUGE

VOLUME OF WATER IN TANK—IN PERCENT OF TOTAL VOLUME

Drawing No. 2600556

VOLUMES IN HORIZONTAL TANKS
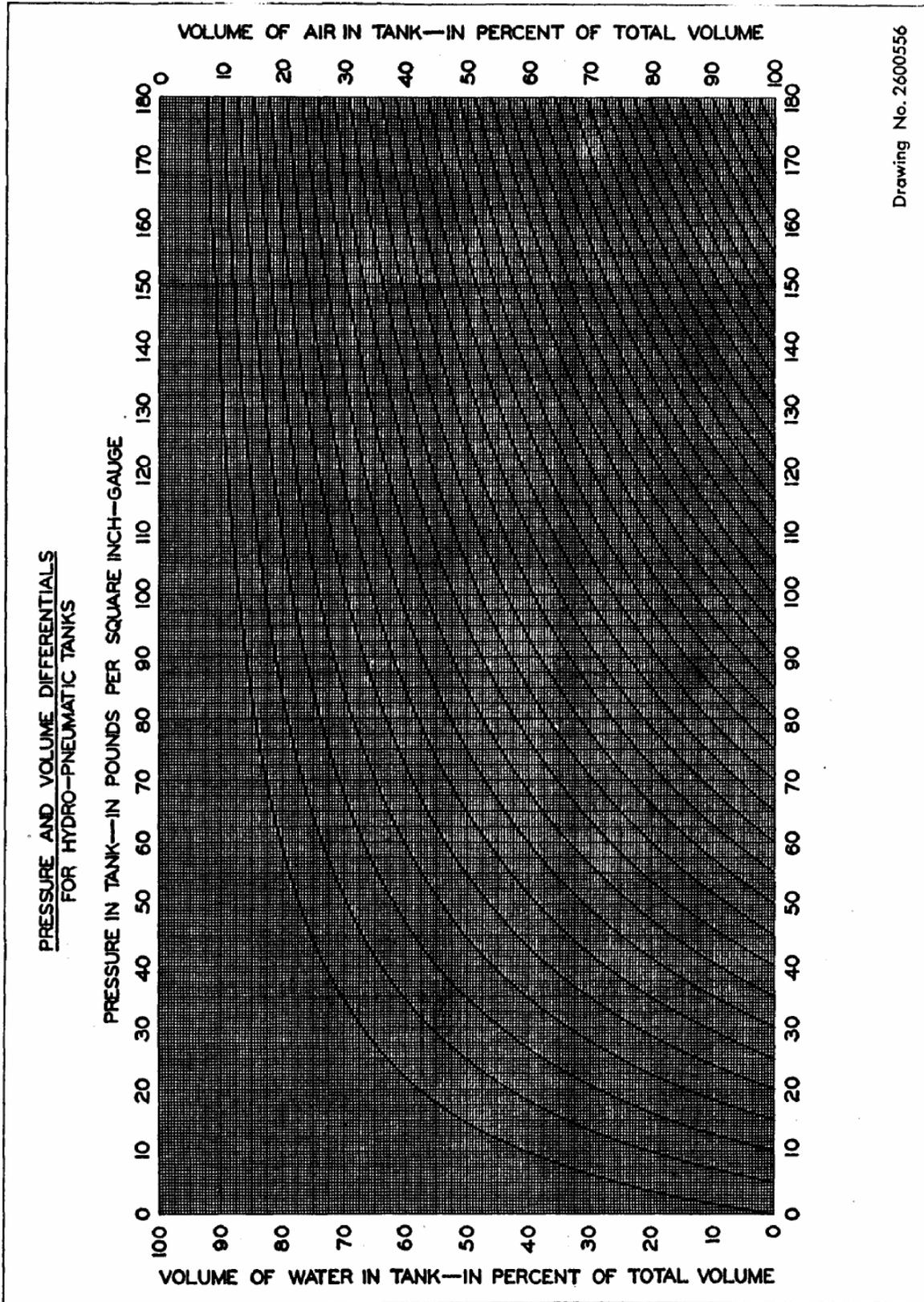
TANKS

CYLINDRICAL — HORIZONTAL

CAPACITY-HEIGHT CONVERSION

RATIO OF $\frac{H}{D}$

VOLUME IN U.S. GALLONS PER FOOT OF LENGTH

DIAMETER IN INCHES
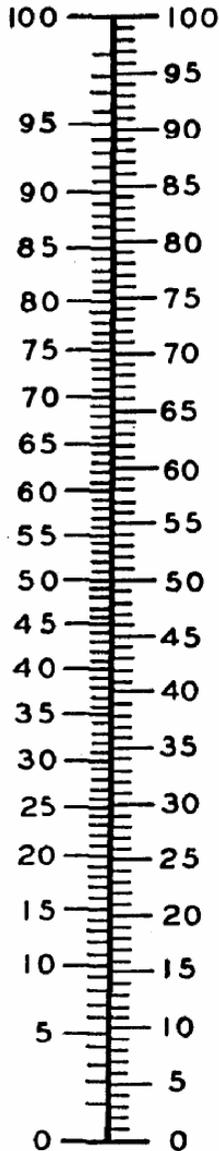
Drawing No. 2800757

Drawing No. 2600463

The Automatic Control Company of St. Paul, Minnesota, have copyrighted a slide rule which they call the "HYDRO-PNEUMATIC TANK CALCULATOR." This rule is based on curves similar to those shown on drawing 2600556 (page 8) and is very convenient for indicating at a glance the best HWL. The slide also has a capacity-height conversion chart similar to drawing 2600463 (page 9) and instructions for selecting an efficient size of tank.

![Peerless Pump logo]

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HYDRO PNEUMATIC TANKS

PUMPING DIFFERENTIAL—IN PERCENT OF TOTAL VOLUME

Drawing No. 2600557
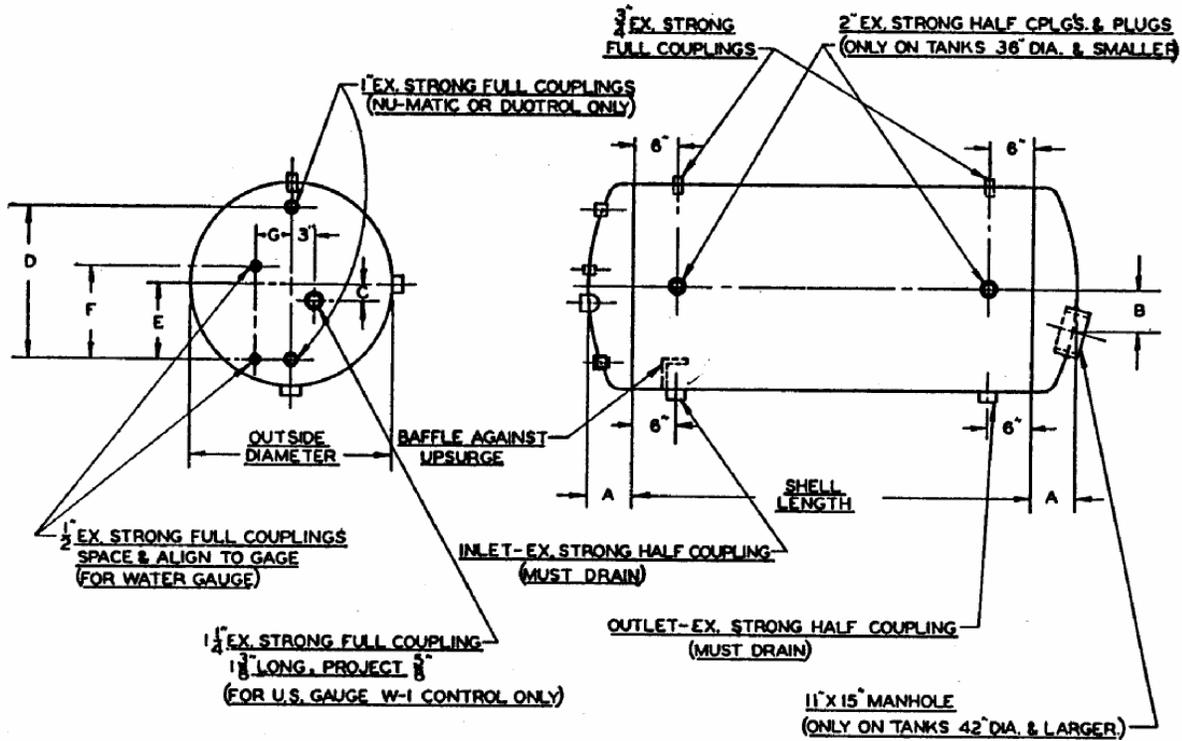
Drawing No. 2800693

Note: Dimensions for tanks are taken from National Tank & Mfg. Co.'s standard for A.S.M.E. code construction. Tanks may vary from the dimensions indicated but sizes and relative locations of openings shall be maintained. Tanks shall be constructed to withstand working pressures as specified on purchase order.

FOR: 60-40 & 40-20 P.S.I. PRESSURE RANGES

| Tank O.D.	Shell Length	Approx. Tank Capacity	Inlet Pipe Size	Outlet Pipe Size	A Approx.	B	DIMENSION IN INCHES						
							60-40 C	40-20 C	D	E	60-40 F	40-20 F	G
30"	84"	275	1½"	1½"	8½	....	3¾	1½	24½	12¼	11	14	5½
30"	96"	310	1½"	1½"	8½	....	3¾	1½	24½	12¼	11	14	5½
30"	120"	380	1½"	1½"	8½	....	3¾	1½	24½	12¼	11	14	5½
36"	84"	400	2"	2"	10	....	4½	1¾	29	14½	12	15	6
36"	96"	450	2"	2"	10	....	4½	1¾	29	14½	12	15	6
36"	120"	550	2"	2"	10	....	4½	1¾	29	14½	12	15	6
42"	96"	620	2½"	2½"	11½	10½	5¼	2	35	17½	15	18	6
42"	108"	700	2½"	2½"	11½	10½	5¼	2	35	17½	15	18	6
42"	120"	760	2½"	2½"	11½	10½	5¼	2	35	17½	15	18	6
42"	144"	900	2½"	2½"	11½	10½	5¼	2	35	17½	15	18	6
42"	156"	980	2½"	2½"	11½	10½	5¼	2	35	17½	15	18	6
42"	168"	1050	2½"	2½"	11½'	10½	5¼	2	35	17½	15	18	6
48"	120"	1077	3"	3"	13	12	6	2¼	39	19½	18	20	6
48"	156"	1500	3"	3"	13	12	6	2¼	39	19½	18	20	6
48"	192"	1641	3"	3"	13	12	6	2¼	39	19½	18	20	6
48"	240"	1925	3"	3"	13	12	6	2¼	39	19½	18	20	6
54"	192"	2073	3"	3"	14½	13½	6¾	2½	43	21½	18	22	6
54"	240"	2400	3"	3"	14½	13½	6¾	2½	43	21½	18	22	6
60"	168"	2180	3"	3"	16	15	7½	3	48	24	20	24	6
60"	216"	2800	3"	3"	16	15	7½	3	48	24	20	24	6
66"	240"	3745	4"	4"	11½	16½	8¼	3¼	52	26	22	26	6
72"	276"	5097	4"	4"	19	18	9	3½	56	28	24	28	6
72"	288"	5270	4"	4"	19	18	9	3½	56	28	24	28	6

![Peerless Pump logo]

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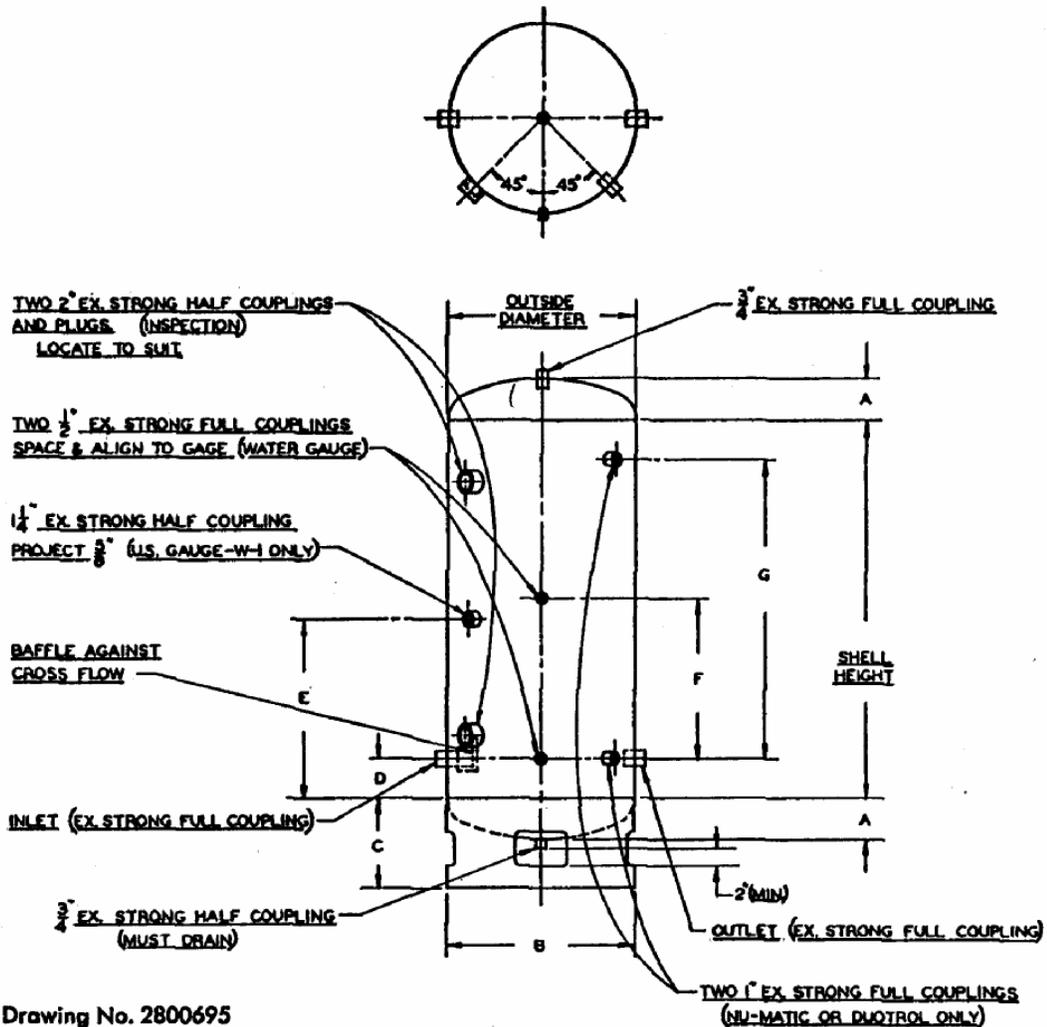
Drawing No. 2800695

Note: Dimensions for tanks are taken from National Tank & Mfg. Co.'s standard for A.S.M.E. code construction. Tanks may vary from the dimensions indicated but sizes and relative locations of openings shall be maintained. Tanks shall be constructed to withstand working pressures as specified on purchase order.

FOR: 60-40 & 40-20 P.S.I. PRESSURE RANGES

Tank O.D.	Shell Height	Approx. Tank Capacity	Inlet Pipe Size	Outlet Pipe Size	A Approx.	B Approx.	C	D	60-40 E	60-40 F	40-20 E	40-20 F	G
16″	48″	46	1¼″	1¼″	5	16⅜	11	2	18¼	20	22½	25	44
16″	60″	56	1¼″	1¼″	5	16⅜	11	2	22½	25	27½	30	56
18″	48″	59	1¼″	1¼″	5½	18⅜	11½	2	18¼	20	22½	25	44
18″	60″	72	1¼″	1¼″	5½	18⅜	11½	2	22½	25	27½	30	56
20″	60″	90	1¼″	1¼″	6	20⅜	12	2	22½	25	27½	30	56
22″	60″	109	1¼″	1¼″	6½	22⅜	12½	2	22½	25	27½	30	56
24″	60″	132	1½″	1½″	7	24⅜	13	2	22½	25	27½	30	56
24″	72″	155	1½″	1½″	7	24⅜	13	2	26¾	30	32¾	36	68
30″	60″	205	1½″	1½″	8½	30⅜	14½	2	22½	25	27½	30	56
30″	72″	240	1½″	1½″	8½	30⅜	14½	2	26¾	30	32¾	36	68
36″	72″	350	1½″	1½″	10	36⅜	16	2	26¾	30	32¾	36	68

III. COMPONENTS

THE HYDRO-PNEUMATIC PRESSURE TANK

Two factors should be considered when specifying the construction of the pressure tank. They are the minimum safe working pressure which the tank must withstand in service and the possibility of corrosion which will affect the anticipated safe working life of the tank.

Working Pressure

The minimum safe working pressure for the tank is generally established at 125 percent of the maximum system pressure but if the maximum pressure developed by the pump exceeds this value the latter pressure should be substituted. In our hypothetical problem the maximum system pressure was established at 60 P.S.I., therefore, 125/100 x 60 = 73 P.S.I. or the minimum safe working pressure for which the tank is to be constructed. Some local ordinances require that tanks which are to be installed in schools or other similar public buildings be constructed to withstand a minimum safe working pressure of 100 P.S.I. In such cases the local requirements should have preference.

The possibility of corrosion within the tank should be given serious consideration. Where corrosive conditions cannot he prevented or minimized, it is advisable to specify heavier tank metal thickness so as to insure a satisfactory safe tank life. It is recommended that 3/16" minimum metal thickness be specified for all tanks although a lighter metal thickness would meet the pressure requirements.

Construction

Practically all of the States have laws or codes governing the construction of hydro-pneumatic pressure tanks. Generally tanks constructed to meet the minimum requirements of the "A.S.M.E. Code for Unfired Pressure Vessels" will he acceptable. So-called "No Code" tanks shall not be used in any State wherein their use is restricted or forbidden. It is advisable to check the latest edition of the code so as to determine all necessary details of construction.

Foundation

Installing a vertical tank is relatively simple and does not require any unusual procedures but the installation of a horizontal tank does require some recommended considerations. For instance, the saddles which support the horizontal tank should be on slightly different elevations so that the tank will slope toward the drain line and thus provide for complete drainage. When the tank is placed upon concrete saddles it is advisable to make the radius of the saddle sufficiently large so that insulation material may be applied between the tank and the concrete. This material should accomplish three purposes. It should provide some resilience to compensate for expansion and contraction which occurs because of the pressure differentials in the tank, it should provide protection against outside corrosion of the tank at the saddle positions and it should protect the tank from failure as might he the case if the tank were allowed to rub on the rough surfaces of the concrete.

A proved and satisfactory method of insulation has been accomplished by the use of a resilient, medium felt pad although several layers of a satisfactory roofing felt may be substituted. Each pad is cut so that it will extend at least an inch beyond the edges of the concrete saddle. The tank is marked for locating these pads in their proper position. The felt is then completely saturated with tar, preferably a hot roofing type, and then the pads are firmly placed in their respective positions within the markings on the tank. Also, generously tar swab the saddle surfaces against which the felt will rest. When the tank is lowered carefully into position upon the saddles it may be good insurance to check and, if necessary, seal any cracks or crevices which might allow moisture to collect near the tank.

The accumulation of moisture at the saddle positions which might cause corrosion of the tank can be eliminated by casting a drain recess in the lowest part of each saddle so that it will be impossible for any moisture to collect.

Good installation practice indicates that the tank saddles should be spaced not more than 7'-0" apart.

Metal saddles are sometimes used in place of concrete. It is recommended that when used they should be of the hinged type with proper contour plates and firmly and accurately spaced by means of suitable tie rods.

Piping

General Data
The piping in a hydro-pneumatic pressure system shall conform with the best piping practice standards, that is, all pipes shall be cut to fit into position without strain, be deburred by reaming; all threads shall be cleanly cut and thoroughly cleaned before making up the joints; a suitable thread compound, properly applied, should be used both as a lubricant and seal to insure against loss by leakage of either air or water.

Other considerations are also essential to a well functioning plant, some of which are indicated below:

A union or flange connection should be placed in each pipe line as close as convenient to each major part of the system which may require removal for servicing or repair.

When the soil formation or other local conditions are not favorable, include additional elbows and piping in both the inlet and outlet lines at the tank in order to provide a swing connection which will give flexibility if the tank settles unevenly. By firmly anchoring the piping to suitable supports, stresses caused by the action of the swing connection will be prevented from being transmitted to the rubber hose insulation members, the pump discharge connection or the connections to the system.

Although the pressure switch line can be connected directly to the air side of the tank, it is better practice to connect it to the water outlet piping close to the tank so as to provide water sealing at the pipe joints and thus contribute against the leakage of air.

All check valves used in either the water or air lines should be of the non-slam type. Although slightly more expensive than common check valves, they are economical because of their contribution to a quietly operating system. If other than non-slam valves are considered for installations where first cost economies are required, they should be of the composition disc, dash pot or leather faced disc type.

Valves
When a separate air compressor is used for supplying air to the pressure tank, it is recommended that the air line check valve be placed as close as possible to the tank. Standard practice indicates the desirability of installing double checks in this line to insure against any possibility of back pressure leakage.

Double check valves should also be considered for installation in the pump discharge line into the tank for all systems where back pressure leakage into the supply line may not be desirable. Where local ordinances demand, a non-siphoning back-flow protection unit should be installed.

The stop-valves in the water lines preferably should be of the composition disc type although gate types can be used. The stop-valves in the air lines should be either of the needle valve or the composition disc type.

Air Protection

The air entering a hydro-pneumatic pressure system should not be contaminated by dust, fumes, smoke, insects, etc. Therefore, it will be necessary to pipe the air from as pure a source as possible and then provide additional protection by the use of a suitable filter installed at the inlet end of the pipe line. The filter must be cleaned or replaced at frequent intervals so it should be placed in a convenient location for accomplishing this purpose.

Drain lines which allow an unrestricted opening into the system during periodic intervals must also be protected against the entrance of dust, fumes, insects, etc. into the system. This protection can be accomplished by the use of a satisfactory strainer installed on the end of the drain line pipe.

SYSTEMS OPERATION AND CONTROL

The proper operation of a hydro-pneumatic pressure system relies primarily upon the simultaneous functioning of two distinct methods of control within the tank. The one method supplies and maintains the proper air volume by establishing the HWL while the other maintains the required pressure differentials.

Supplying the air and maintaining the desired HWL can be accomplished in three different basic ways:

1. By means of a valving arrangement which allows the water in part of the pump discharge line to drain out and be replaced with air. The entrapped air is then forced into the tank. This method is generally used with deep well pump type installations and is accomplished by a control device similar to the U. S. Gauge Company's Type W-1 Air Volume Control or the Automatic Control Company's Type DS Duotrol.

2. By means of a specially constructed air displacement arrangement that automatically operates through a combination of a float and valves which function by means of the pressure maintained in the tank. This method can be used with any type of hydro-pneumatic system and is accomplished by a control device similar to the Nu-Matic Water Level Control.

3. By means of a separate, standard type air compressor which is operated by means of a float type water level control. This method is generally used with the booster type installations and is accomplished by a control similar to the Automatic Control Company's Type DC Duotrol.

The operating arrangement for deep well pump type installations can be selected for a variety of combinations of the air volume control, as follows:

Deep Well Type

1. Deep well type pumps similar to the Peerless "Hi-Lifts (or Deep Well Type pumps when equipped with a foot valve on the suction) are arranged to drain part of the discharge pipe line so that the entrapped air can be forced into the tank with each pumping cycle. The foot valve on the pump suction retains the water in the pump column after each pumping cycle. Both the drain valve and the air inlet valve open, allowing the water in part of the discharge line to drain out and be replaced with air. When the pump again starts, its pressure closes both the drain and air inlet valves and forces the air into the tank. Excess air is bled- off from the tank to maintain the proper volume for maintaining the HWL. The U. S. Gauge Company's Type W-1 Air Volume Control accomplishes this by means of a combination float and pressure relief valve operating in series; while the Automatic Control Company's Type DS Duotrol functions by operating a solenoid type air release valve. Typical assemblies of these are shown in Drawing 2800849 (page 19).

2. Conventional deep well type pumps (not equipped with foot valves on the suction) allow the water in the pump column and discharge line to drain back into the well after each pumping cycle. In this arrangement a suitable float vent valve, with the vacuum ball removed, opens to allow air to enter with receding water levels and again to close with a rise of water into the valve when the pump starts. The pipe nipple to which the vent valve is attached is arranged with a long thread on the discharge pipe end so that it can be extended far enough into the pipe to trap air and force it into the pressure tank. The distance that the nipple extends into the pipe must be determined by trial. The excess air is bled-off from the tank and the HWL maintained in the same manner as in arrangement Number 1. A typical assembly of this arrangement is shown on drawing 2800848.

3. Conventional deep well type pump systems can also be arranged for the air displacement compressor type of air volume and water level control. A float vent valve is also used in this arrangement but it is placed as close as possible to the discharge line check valve and with a standard pipe connecting nipple which allows for complete air venting. An arrangement similar to the Nu-Matic Water Control then functions to supply air into the tank and maintain the desired HWL.

4. Conventional deep well pump type systems can also be arranged for use with standard type air compressors. A float vent valve is used in the same way as is described in arrangement Number 3 and an air volume control similar to the Automatic Control Company's Type DC Duotrol is used in place of the Nu-Matic Type Control. The Type DC Duotrol maintains the proper air volume and HWL by operating the air compressor which forces air into the tank through a solenoid type air inlet valve.

Booster Type Systems

5. The pumps used with conventional Booster Type Systems take their water from either a municipal supply or a separate, closed type reservoir. The air volume and HWL in the pressure tank is controlled by either the Nu-Matic Type or the Type DC Duotrol with separate air compressor. Drawing 2800847 (page 20) shows a typical assembly of the arrangement when the Nu-Matic Control is used while Drawing 2800846 shows a typical assembly of the arrangement for a duplex pump system when the Type DC Duotrol is used.

Combination Systems

6. The combination type pneumatic system consists of a deep well pump supplying water to a closed type reservoir from which a conventional Booster Type System takes its requirements. Any type of deep well pump can be used to pump directly into the reservoir. A two circuit float switch type of control can be installed in the reservoir for controlling the pumps. One circuit controls the starting and stopping of the deep well pump within relatively close operating limits while the second circuit controls the booster pump only when insufficient water is available in the reservoir for supplying the pressure system. This float switch can be similar to a special arrangement of the Automatic Control Company's Type S, two circuit Floatrol built to Peerless Pump specifications. Standard type controls may be selected for the Booster Type System. Drawing 2800845 shows a typical assembly of this arrangement.

Cushion Tank System

7. The air for the tank used with the Cushion Tank System is manually injected by means of an ordinary tire pump. A typical assembly of this system is shown on Drawing 2800844.

All deep well type pumps should be controlled against reverse rotation after each pumping cycle by the use of either an anti-reverse ratchet or a time delay arrangement. This recommendation is evident because damage to the pump is possible if the motor should be started while the pump was operating in reverse during the back-flow cycle.

Maintaining the pressure in the tank within the required limits is accomplished by means of a standard type pressure switch which is used with all of the pressure systems. The pressure switch generally is used as a pilot for energizing the motor starter circuit.

Other equally important controls are also essential to the completely safe, automatic functioning of the system.

The motor starting and protection devices consist of a motor switch and a motor starter. Sometimes, for convenience, these two devices are built into a single cabinet which is called a combination starter. It is advisable to have a "Hand-AutomaticOff" station installed in the starter so that the system can be operated manually when adjusting the various control devices, making repairs, etc. Motor protection devices and starters are recommended for each motor used in the system.

All hydro-pneumatic pressure tanks must be protected against accidental, excessive pressures by using an acceptable pressure relief valve. The relief valve should be set to open at a pressure greater than the highest system pressure but well within the safe working limit of the tank.

![Peerless Pump logo]

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TYPICAL HYDRO-PNEUMATIC PRESSURE SYSTEMS

TYPICAL DEEP WELL PUMP TYPE HYDRO-PNEUMATIC PRESSURE SYSTEM

(Without Foot Valve on Pump Suction; With Automatic Control Company's Type DS Duotrol)

1—Combination Starter
2—Pressure Switch
3—Deep Well Pump
4—Rubber Hose Connection
5—Float Vent Valve
6—Air Filter
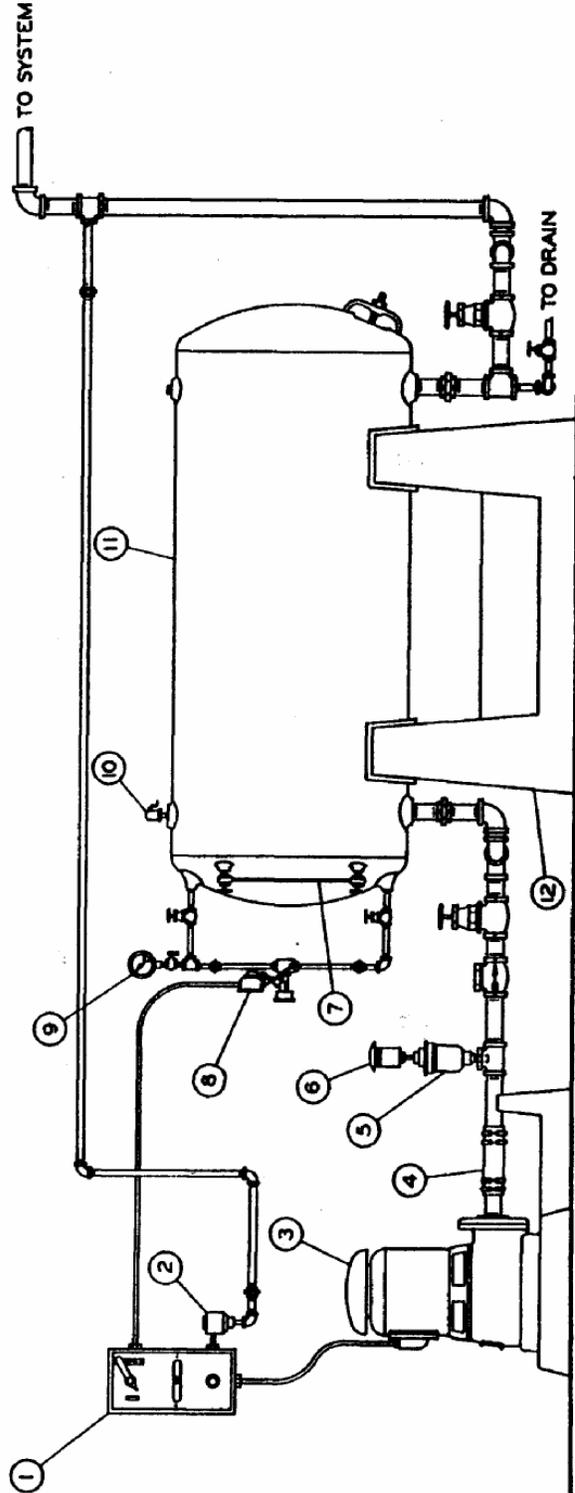
7—Water Gauge
8—Type DS Duotrol
9—Pressure Gauge
10—Pressure Relief Valve
11—Pressure Tank
12—Tank Saddles

Drawing No. 2800848

TYPICAL DEEP WELL PUMP TYPE HYDRO-PNEUMATIC PRESSURE SYSTEM

(With Foot Valve on Pump Suction and U. S. Gauge Type W-1 Air Volume Control)

1—Combination Starter
2—Pressure Switch
3—Strainer
4—Water Drain Valve
5—Deep Well Pump
6—Rubber Hose Connection
7—Pressure Relief Valve

8—Air Inlet Valve
9—Air Filter
10—Tank Saddles
11—Type W-1 Air Volume Control
12—Pressure Tank
13—Water Gauge
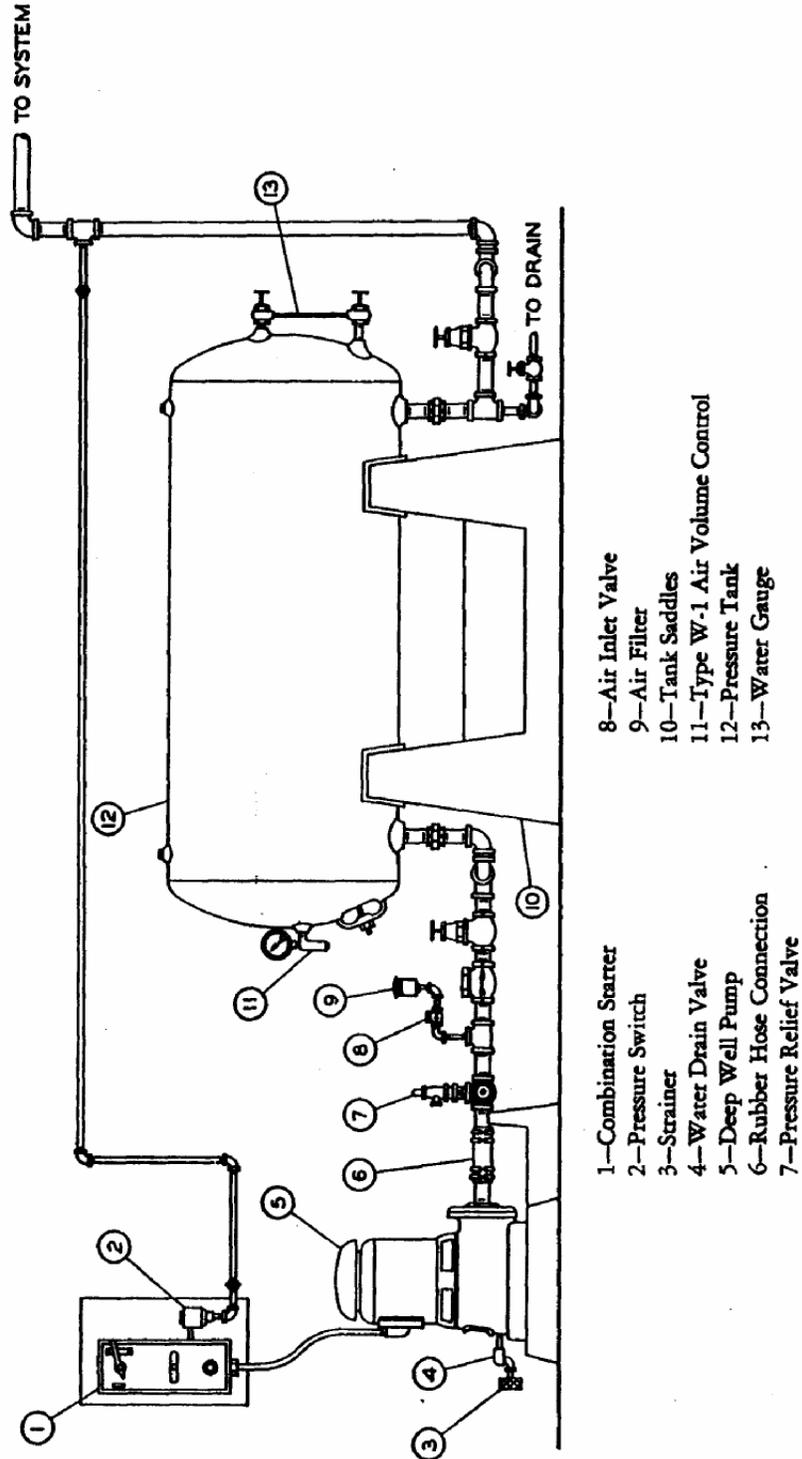
Drawing No. 2800849

![Peerless Pump logo]

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TYPICAL BOOSTER TYPE HYDRO-PNEUMATIC PRESSURE SYSTEM
(With Nu-Matic Water Level Control)
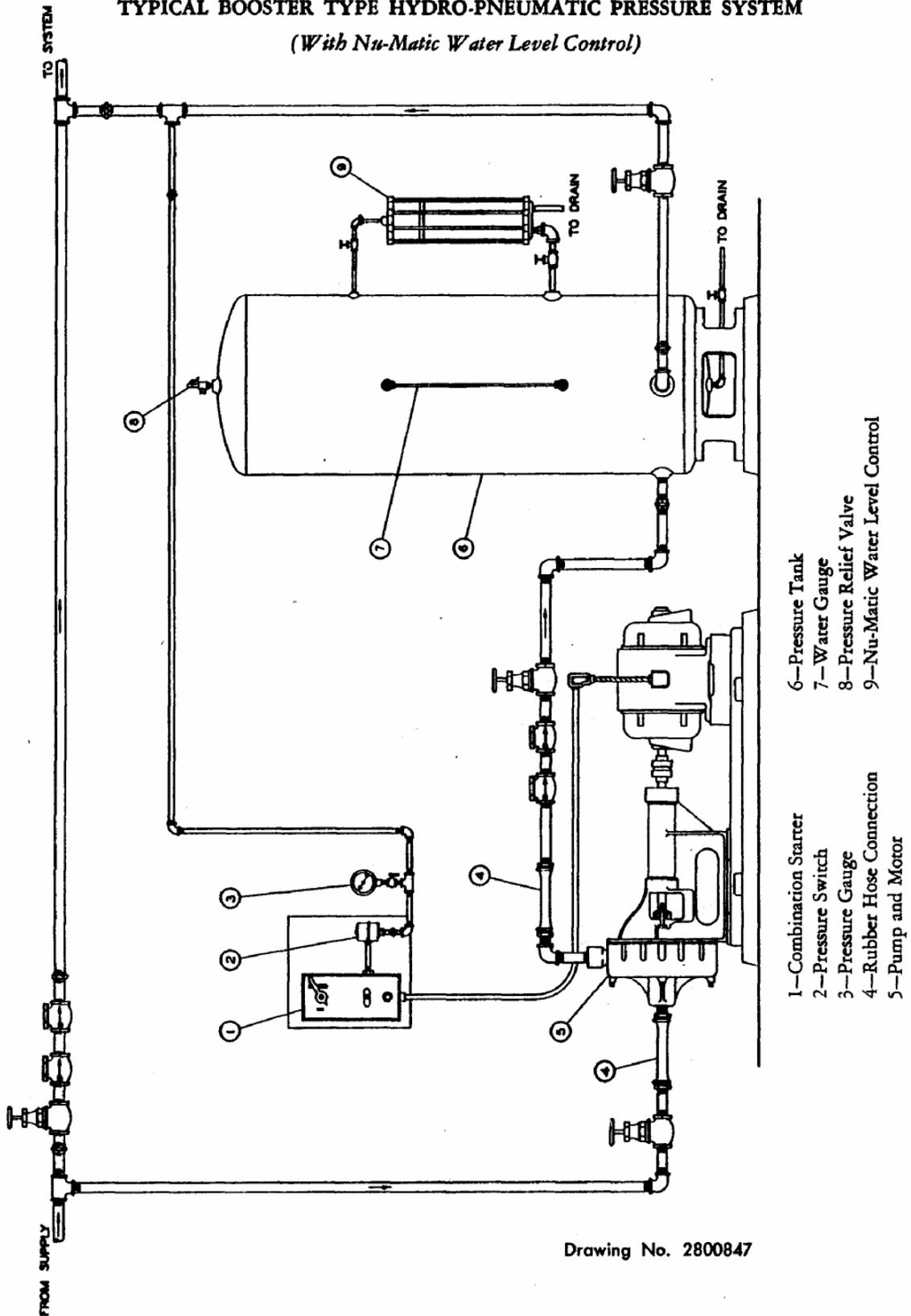
1—Combination Starter
2—Pressure Switch
3—Pressure Gauge
4—Rubber Hose Connection
5—Pump and Motor
6—Pressure Tank
7—Water Gauge
8—Pressure Relief Valve
9—Nu-Matic Water Level Control

Drawing No. 2800847

20

![Peerless Pump logo] *PEERLESS PUMP*

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TYPICAL DUPLEX BOOSTER TYPE HYDRO-PNEUMATIC PRESSURE SYSTEM

(With Automatic Control Company's Type DC Duotrol)

1—Rubber Hose Connection
2—Pump and Motor
3—Air Compressor and Motor
4—Tank Saddles
5—Pressure Tank
6—Pressure Relief Valve
7—Pressure Gauge
8—Water Gauge
9—Type DC Duotrol
10—Combination Starters
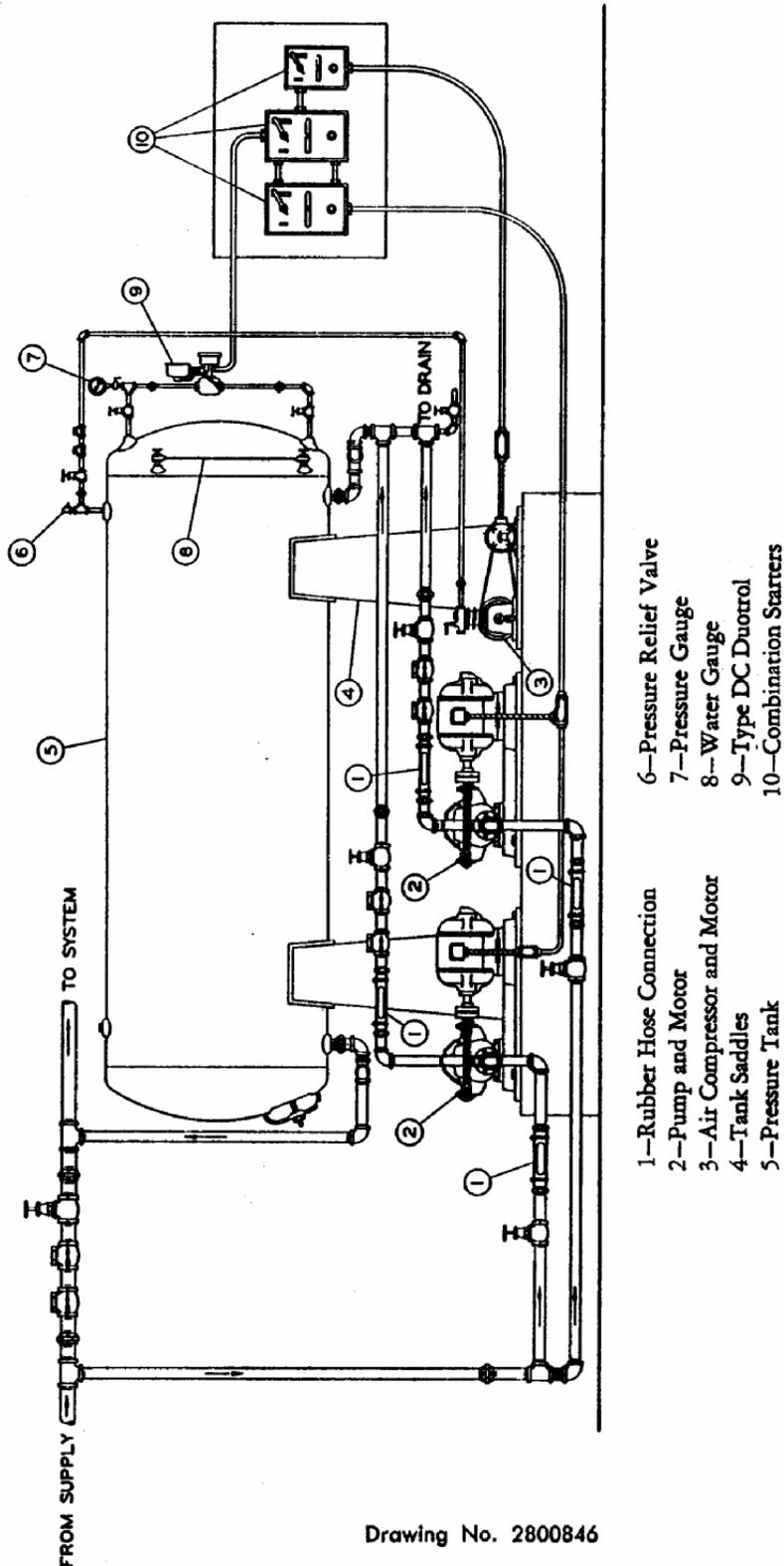
Drawing No. 2800846

TYPICAL COMBINATION TYPE HYDRO-PNEUMATIC PRESSURE SYSTEM

(With Automatic Control Company's Floatrol on Reservoir and Nu-Matic Water Level Control on Pressure Tank)

1—Deep Well Pump
2—Combination Starter
3—Rubber Hose Connection
4—Floatrol
5—Reservoir Tank
6—Air Filter
7—Water Gauge

8—Tank Saddles
9—Booster Pump
10—Pressure Switch
11—Pressure Gauge
12—Pressure Relief Valve
13—Pressure Tank
14—Nu-Matic Water Level Control

Drawing No. 2800845

![Peerless Pump logo]

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TYPICAL CUSHION TANK TYPE SYSTEM
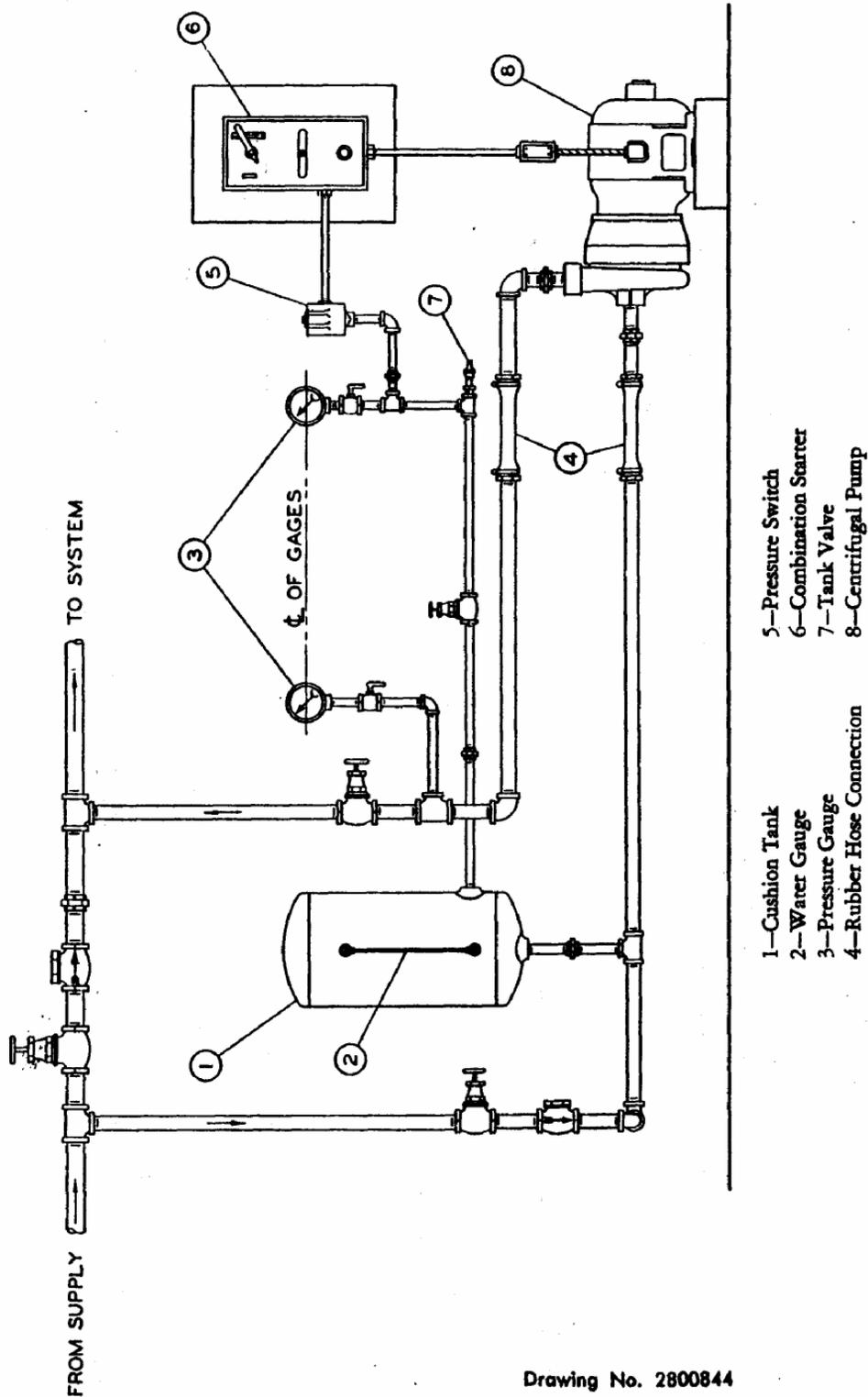
1—Cushion Tank
2—Water Gauge
3—Pressure Gauge
4—Rubber Hose Connection

5—Pressure Switch
6—Combination Starter
7—Tank Valve
8—Centrifugal Pump

Drawing No. 2800844

23

IV. AUXILIARY EQUIPMENT

The following list of auxiliary equipment ordinarily used with hydro-pneumatic pressure systems is intended only as a guide for parts selection and to indicate a brief description of their operation and function in the system. The various manufacturers' names, type or class and size designation are given only for reference purposes and no restriction to the substitution of equivalent equipment is intended.

1. AIR VOLUME CONTROLS:
(a)   The U. S. Gauge Company's Air Volume Control is manufactured by the Division of American Machine and Metals, Inc., located in Sellersville, Pa.

The type W-1 Control is a combination float and pressure relief valve operating in series. Its function is to bleed-off the excess air that has been forced into the pressure tank either by the pump itself or by an auxiliary means operating in conjunction with the pump.

The standard type W-1 Control is stocked for operating between 20 P.S.I. and 40 P.S.I. The relief valve is set to open at 25 P.S.I. although this pressure may be varied in the field by resetting the tension of the valve spring. When first putting the system into operation, it is advisable to reset the relief pressure until, by observing through the water gauge glass, the HWL in the tank coincides with the approximate center of the pipe coupling into which the control is installed.

(b)   The Nu-Matic Water Control is manufactured by the Nu-Matic Company, located in Alhambra, California.

This control functions as a compressor for supplying air into the pressure tank. By means of a float and special valves, it utilizes the tank pressure for manipulating air into the tank while at the same time establishing and maintaining the desired predetermined HWL. This is entirely different from the action of the U. S. Gauge, Type W-1 Air Volume Control and the Automatic Control Company's Duotrols, which depend on air forced into the tank either by means of the water pump or by a separately driven air compressor.

The Nu-Matic may be used with equal advantage on either the deep well pump or booster type systems. The standard control is built to withstand 150 P.S.I. although a special control suitable for 175 P.S.I. is available on special order. Its disadvantage lies in its slowness in establishing the proper 1-IWL when the system is first put into operation and, like the W- 1 and Type DS Duotrol, in its waste of water. The waste water from the Nu-Matic control tank must be drained by gravity and thus may become a nuisance especially when the control is installed in a basement or cellar which has no drain connection to a sewer or equivalent run-off.

(c)   The Types DS and DC Duotrol are manufactured by the Automatic Control Company of St. Paul, Minnesota.

The type DS Duotrol is furnished with deep well pump type systems which force excess air into the pressure tank by means of the water pump. The Type DC Duotrol is furnished with either deep well pump or booster type systems in which air is supplied to the pressure tank by means of a separate compressor. The controls are identical except for the reversed operation of the air switch which bleeds-off the excess air in the tank in the DS Type and allows air to be injected into the tank in the DC Type.

Both types of control combine the two separate functions of the air volume and pressure switch control in one assembly and thus simultaneously control and maintain the desired water levels within fixed pressure limits and also

automatically maintain the correct air volume within the tan[1]. Either type can be furnished for a maximum pressure of 150 P.S.I. Field settings of the high and low pressure controls are conveniently placed and simple to adjust.

The Duotrols are the only controls which are presently available for single pump, two pump, two pump with automatic alternator or three pump operation in either the DS or DC types.

The type desired, maximum and minimum pressure settings and operating voltage must be specified when ordering these controls.

2. PRESSURE SWITCHES:
Pressure switches are used for maintaining the predetermined pressure differentials in the pressure tank. They are used as pilot circuits for starting the pump when the pressure in the tank reaches the low operating limit and again to stop the pump when the high operating limit is reached. Switches similar to the Square D Company's Class 9013, Types GSG (80 P.S.I. Max.) and GHG (200 P.S.I. Max.) have given satisfactory service. Pressure settings and current characteristics must be specified when ordering.

3. PRESSURE RELIEF VALVES:
Pressure relief valves are used to protect the system against damage because of either excessive water or air pressures. They are the safety valves of the system and, therefore, should be checked frequently to keep them in the best operating condition. They should be set to operate at a safe value above the maximum system pressure but always within the safe working limits of the tank or other parts which are to be protected and also selected with sufficient capacity to vent-off all excess pressure.

Pressure relief valves similar to those manufactured by the Consolidated Valve Division; Manning, Maxwell and Moore, Inc., of Bridgeport, Conn., have been found satisfactory in operation.

When used on the water end of the system, Type 1485 is recommended. They are built for a maximum of 200 P.S.I. pressure and are available in sizes from ½" to 4" inclusive. When used on the air end of the system, Type 1445 is recommended. These are pop type safety valves which meet A.S.M.E. approval and are available in sizes from s/a" to 2" inclusive. Pressure settings must be specified when ordering.

4. PRESSURE GAUGES:
Pressure gauges are used for indicating the pressures existing in the system. Instruments similar to the Fig. 500S as manufactured by the U. S. Gauge Company are acceptable. Dial sizes from 2" to 3" diameter are available. Gauges should be selected to register maximum pressures at least equal to the required tank test pressure. Specify dial size and maximum pressure when ordering.

5. COMBINATION STARTERS:
Combination starters provide safety as well as the means for automatically starting the pump and compressor motors. Units similar to the Square D Company's Class 8538 are recommended. They consist of a fusible safety disconnect switch and a starter protected against overload by either melting alloy or bi-metallic relays. We suggest that the starter be equipped with a "Hand-Automatic-Off" control mounted in the cover. When ordering specify motor size, current characteristics, fuse size, type of overload relay desired and "Hand-Automatic-Off" control.

6. AIR INLET VALVES:
Air inlet valves are used on deep well systems which utilize part of the pump discharge line for air charging the tank. A leather faced swing check valve mounted horizontally has been found satisfactory. It should be installed for flow into the line and close against line pressure. Valves similar to Crane Company's number 34½ brass check,

leather faced disc are recommended. They are obtainable in sizes from 3/g" to 2", inclusive. Specify type number and size when ordering.

7. WATER DRAIN VALVES:

Water drain valves are also used on deep well systems which utilize part of the pump discharge line for air charging the tank. They are furnished in two types: the ball check and the solenoid type.

(a)   The ball check type is manufactured by Peerless Pump Division of the Food Machinery and Chemical Corporation. It is spring loaded to hold the ball away from its seat when the pumping pressure is released. This allows the water in the pump discharge line to bleed back to waste and be replaced by air entering through the air inlet valve. When the pump operates, the pressure forces the ball back against its seat. It is made in only one size with a ¾" standard male pipe thread connection. The ball check valve allows for drip leakage at all times so if no leakage can be tolerated, a solenoid type should be specified.

(b)   Acceptable solenoid valves are similar to the Type K-1O as manufactured by General Controls Company of Glendale, California. They should be of the normally open type and with either a 3/8" or ½" standard pipe connection and an orifice as large as practical which will allow the magnet to operate against a pressure of at least 5 P.S.I. greater than the maximum system pressure. When ordering specify connection size, pressure requirement, orifice size and electric current characteristics.

8. AIR FILTERS:

Air filters are placed on the intake lines to the air compressor, air inlet valves and vent connections when and as required. They are used to protect the system from atmospheric contaminations. Filters similar to those built by the Air- Maze Corporation of Cleveland, Ohio, have been found satisfactory for most applications.

Sizes and types ½" (GCOHS),¾"(GBOHS), 1" (GAOHS) and 1¼" (GJOHS) are available. The filters can be used in the dry state but for maximum protection, the filter should be charged with a refined, edible oil. Frequent cleansing is recommended. Specify size and type when ordering.

9. STRAINERS:

Strainers are placed on the end of the water drain valves to protect the system against entrance of any possible contamination. Sizes and types: ½" (OHGC) and ¾" (OHGB) similar to those manufactured by the Air-Maze Corporation are satisfactory. Specify size and type when ordering.

10. AIR RELEASE AND AIR INJECTOR VALVES:

Solenoid type valves are furnished with the Type DS Duotrols and can be ordered for use with the Type DC Duotrols. When desired separately; the Type K-b, normally closed valves as manufactured by the General Controls Company are satisfactory for use. They are available with either /8" or ½" standard pipe connection. When ordering, specify connection size, pressure requirements, orifice size and electric current characteristics.

11. TANK VALVES (SNIFTER TYPE):

Tank valves are used with cushion tank type systems for charging the tank and setting the controls. The Schrader Number 645 valve is satisfactory for use. It is available with a ½" male pipe connection.

12. CHECK VALVES:

Thoughtful specification and selection of check valves for use in the piping lines of pneumatic pressure systems contributes to installation efficiency. Noisy, slamming valves should not be tolerated and definitely have no place in systems supplying hospitals, sanitariums, hotels and similar installations where noise is detrimental and a nuisance.

Non-Slam type check valves are recommended for use in all Peerless Hydro-Pneumatic pressure systems. Installation experience has shown that valves similar to the Cla-Val No-Slam check valve Number 81, as manufactured by the Cla-Val Company of Alhambra, California, have been found very satisfactory in operation. These valves are made in two pressure classifications: 150 P.S.I. and 300 P.S.I. The 3/8", ½" and ¾" sizes are made with integral valve seats while larger sizes have renewable seats. The screwed type fittings are made in sizes from 3/s" to 3" inclusive while the flanged type are made in 2" to 16" sizes. These valves may be used on either the water or air lines. When ordering, specify size, whether screwed or flanged type is desired, pressure class, temperature, type of fluid being handled and flowing and static line pressure.

When other than Non-Slam valves are used because of first cost economics, it is recommended that they be either of the composition disc type or leather faced swing check valve type.

Brass leather faced swing check valves are similar to Crane Company's Number 34½ in the threaded type in sizes from /8" to 2", inclusive, while similar cast iron, brass trimmed valves are Crane Company's Number 372 in the threaded type and Number 373 in the flanged type. Sizes from 2" to 8" inclusive are available. Specify size and type by number when ordering.

13. STOP VALVES:

Composition disc, globe type stop valves are recommended for all water lines although gate type valves can also be used. Needle type valves are recommended for air lines.

Composition disc, brass globe type valves similar to Crane Company's Number 7 have been found satisfactory. They are rated at 150 P.S.I. and are available in sizes from ½" to 3", inclusive.

Brass, wedge type gate valves similar to Crane Company's No. 437 are rated at 300 P.S.I. and are available in sizes from ¼" to 3", inclusive. Iron body, brass trimmed valves similar to Crane Company's Number 460 are available in sizes from 2" and larger.

Brass, globe needle point valves similar to Crane Company's Number 88 are available in sizes from ½" to 3/4", inclusive. Specify size and type when ordering.

14. FLOAT VENT VALVES:

Float vent valves are used with deep well pump systems and perform the dual function of air inlet and air vent for the pump discharge line. Valves similar to those manufactured by the Valve and Primer Corporation of Chicago, Illinois, are satisfactory.

Valves Number 5 0-60 are satisfactory for use up to 60 P.S.I. and the 50 HD. are good up to 150 P.S.I. Larger capacity units similar to the Number 70 are good up to 125 P.S.I.

When ordering, specify size, type number and also specify that the vacuum ball be removed to allow free inflow through the valve and into the system.

15. WATER GAUGES:

Water gauges are recommended for installation on all pressure tanks so that water levels can readily be determined. Gauges similar to Crane Company's No. 624 (rough) and 610 (polished) are satisfactory. Lengths with centers up to 36" are available. Specify length and type number when ordering.

16. HOSE CONNECTIONS:

Vibration insulating hose connections are recommended for installation in both the suction and discharge lines of the pump and, for some applications, also in the tank outlet line. They are

intended to insulate all pump and tank noises from the system.

Hose connections completely assembled with threaded couplings and hose bands at each end and ready for installation into the piping system are manufactured by the United States Rubber Company. The following sizes are recommended:

1" I.D. x 3 Ply x 18" Long
1¼" I.D. x 3 Ply x 18" Long
1½" I.D. x 4 Ply x 18" Long
2" I.D. x 4 Ply x 18" Long
2½" I.D. x 4 Ply x 24" Long
3" I.D. x 6 Ply x 24" Long

When ordering specify type Number 3400 and give complete size specifications as indicated above. Also, indicate whether plain end or enlarged end hose is desired. For flanged type connections in sizes from 2" I.D. to 8" ID., contact the closest United States Rubber Company office.

17. AIR COMPRESSORS:
Air compressors are used when separately driven air units are desired for injecting air into the pressure tank. Very little air is required by the ordinary pressure system; only sufficient to replace that absorbed by the water in the tank.

Compressors with capacities of 2 to 2½ cubic feet per minute for each 3000 gallons of tank capacity have been found satisfactory for most installations. Either mechanical or electrically operated air pressure unloaders should be specified for use with the compressors as well as a refined, edible oil for their lubrication.

Compressor units similar to the Model D106 or D108 as manufactured by the Quincy Compressor Company of Quincy, Illinois, have been found satisfactory; also, units similar to the style W- 153 to W- 156 as manufactured by the Curtis Manufacturing Company of St. Louis, Mo.

18. FLOAT SWITCH (For Reservoir Tank):
Float switch assembly FM-920-6 is built especially for the Peerless Pump Division by the Automatic Control Company of St. Paul, Minnesota. It is a tape operated float switch which is especially adaptable to the sequence operation desired for control of the water levels in a reservoir tank. It is arranged for flange mounting and utilizes a stilling tube for the protection of the float. The mounting flange is 11 inches in diameter, has 4 equally spaced 5/g" drilled holes on a 9½" bolt circle for mounting upon the stilling tube flange. When ordering specify number FM-920-6 and the control levels desired for both the reservoir supply and booster pump.

FRICTION LOSS OF HEAD (h_t) FOR WATER IN FEET PER 100 FEET OF PIPE
WROUGHT IRON OR STEEL
(SCHEDULE 40)

½″ NOMINAL		¾″ NOMINAL		1″ NOMINAL		1¼″ NOMINAL		1½″ NOMINAL		2″ NOMINAL	
G.P.M.	h_t	G.P.M.	h_t	G.P.M.	h_t	G.P.M.	h_t	G.P.M.	h_t	G.P.M.	h_t
0.7	0.740	1.0	0.260	1	0.114	1.5	0.0623	12	1.16	14	0.453
1.0	1.86	1.5	0.730	2	0.379	2	0.102	14	1.53	16	0.578
1.5	2.85	2.0	1.21	3	0.772	3	0.207	16	1.96	18	0.717
2.0	4.78	2.5	1.80	4	1.295	4	0.342	18	2.42	20	0.868
2.5	7.16	3.0	2.50	5	1.93	5	0.508	20	2.94	22	1.03
3.0	10.0	3.5	3.30	6	2.68	6	0.704	22	3.52	24	1.20
3.5	13.3	4.0	4.21	7	3.56	7	0.930	24	4.14	26	1.39
4.0	17.1	4.5	5.21	8	4.54	8	1.18	26	4.81	28	1.60
4.5	21.3	5.0	6.32	9	5.65	9	1.46	28	5.51	30	1.82
5.0	25.8	6.0	8.87	10	6.86	10	1.77	30	6.26	35	2.42
5.5	30.9	7.0	11.8	12	9.62	12	2.48	32	7.07	40	3.10
6.0	36.5	8.0	15.0	14	12.8	14	3.28	34	7.92	45	3.85
6.5	42.4	9.0	18.8	16	16.5	16	4.20	36	8.82	50	4.67
7.0	48.7	10	23.0	18	20.6	18	5.22	38	9.78	55	5.59
7.5	55.5	11	27.6	20	25.1	20	6.34	40	10.79	60	6.59
8.0	62.7	12	32.6	22	30.2	22	7.58	42	11.8	65	7.0
8.5	70.3	13	37.8	24	35.6	24	8.92	44	12.9	70	8.8
9.0	78.3	14	43.5	26	41.6	26	10.37	46	14.0	75	10.1
9.5	86.9	15	49.7	28	47.9	28	11.9	48	15.2	80	11.4
10	95.9	16	56.3	30	54.6	30	13.6	50	16.4	85	12.8
11	115	17	63.1	32	61.8	32	15.3	55	19.7	90	14.2
12	136	18	70.3	34	69.4	34	17.2	60	23.2	95	15.8
13	159	19	78.0	36	77.4	36	19.2	65	27.1	100	17.4
14	183	20	86.1	38	86.0	38	21.3	70	31.3	110	20.9
15	209	22	104	40	95.0	40	23.5	75	35.8	120	24.7
		24	122	42	104.5	42	25.8	80	40.5	130	28.8
		26	143	44	114	44	28.2	85	45.6	140	33.2
		28	164	46	124	46	30.7	90	51.0	150	38.0
		30	187	48	135	48	33.3	95	56.5	160	43.0
				50	146	50	36.0	100	62.2	170	48.4
				55	176	55	43.2	110	74.5	180	54.1
				60	209	60	51.0	120	88.3	190	60.1
						65	59.6	130	103	200	66.3
						70	68.8	140	119	220	80.0
						75	78.7	150	137	240	95.0
						80	89.2	160	156	260	111
						85	100.2	170	175	280	218
						90	112	180	196	300	146
						95	124	190	218	320	166
						100	138	200	241	340	187
						110	166				
						120	197				

FRICTION LOSS OF HEAD (h_f) FOR WATER IN FEET PER 100 FEET OF PIPE
WROUGHT IRON OR STEEL
(SCHEDULE 40)

2½" NOMINAL		3" NOMINAL		4" NOMINAL		5" NOMINAL		6" NOMINAL		8" NOMINAL	
G.P.M.	h_f	G.P.M.	h_f	G.P.M.	h_f	G.P.M.	h_f	G.P.M.	h_f	G.P.M.	h_f
22	0.430	55	0.789	100	0.624	100	0.204	300	0.637	300	0.163
24	0.502	60	0.924	110	0.744	120	0.286	320	0.719	320	0.184
26	0.580	65	1.07	120	0.877	140	0.380	340	0.806	340	0.206
28	0.663	70	1.22	130	1.017	160	0.487	360	0.898	360	0.229
30	0.753	75	1.39	140	1.165	180	0.606	380	0.993	380	0.253
35	1.00	80	1.57	150	1.32	200	0.736	400	1.09	400	0.279
40	1.28	85	1.76	160	1.49	220	0.879	420	1.20	450	0.348
45	1.60	90	1.96	170	1.67	240	1.035	440	1.31	500	0.424
50	1.94	95	2.17	180	1.86	260	1.20	460	1.42	550	0.507
55	2.32	100	2.39	190	2.06	280	1.38	480	1.54	600	0.597
60	2.72	110	2.86	200	2.27	300	1.58	500	1.66	650	0.694
65	3.16	120	3.37	220	2.72	320	1.78	550	1.99	700	0.797
70	3.63	130	3.92	240	3.21	340	2.00	600	2.34	750	0.907
75	4.13	140	4.51	260	3.74	360	2.22	650	2.73	800	1.02
80	4.66	150	5.14	280	4.30	380	2.46	700	3.13	850	1.147
85	5.22	160	5.81	300	4.89	400	2.72	750	3.57	900	1.27
90	5.82	170	6.53	320	5.51	420	2.98	800	4.03	950	1.41
95	6.45	180	7.28	340	6.19	440	3.26	850	4.53	1000	1.56
100	7.11	190	8.07	360	6.92	460	3.55	900	5.05	1100	1.87
110	8.51	200	8.90	380	7.68	480	3.85	950	5.60	1200	2.20
120	10.0	220	10.7	400	8.47	500	4.16	1000	6.17	1300	2.56
130	11.7	240	12.6	420	9.30	550	4.98	1100	7.41	1400	2.95
140	13.5	260	14.7	440	10.2	600	5.88	1200	8.76	1500	3.37
150	15.4	280	16.9	460	11.1	650	6.87	1300	10.2	1600	3.82
160	17.4	300	19.2	480	12.0	700	7.93	1400	11.8	1700	4.29
170	19.6	320	22.0	500	13.0	750	9.05	1500	13.5	1800	4.79
180	21.9	340	24.8	550	15.7	800	10.22	1600	15.4	1900	5.31
190	24.2	360	27.7	600	18.6	850	11.5	1700	17.3	2000	5.86
200	26.7	380	30.7	650	21.7	900	12.9	1800	19.4	2200	7.02
220	32.2	400	33.9	700	25.0	950	14.3	1900	21.6	2400	8.31
240	38.1	420	37.3	750	28.6	1000	15.8	2000	23.8	2600	9.70
260	44.5	440	40.9	800	32.4	1100	19.0	2100	26.2	2800	11.20
280	51.3	460	44.6	850	36.5	1200	22.5	2200	28.8	3000	12.8
300	58.5	480	48.5	900	40.8	1300	26.3	2300	31.4	3200	14.5
350	79.2	500	52.5	950	45.3	1400	30.4	2400	34.2	3400	16.4
400	103	550	63.2	1000	50.2	1500	34.8	2500	37.0	3600	18.4
450	130	600	74.8	1100	60.5	1600	39.5	2600	39.9	3800	20.5
500	160	650	87.5	1200	72.0	1700	44.5	2700	42.9	4000	22.6
550	193	700	101	1300	84.3	1800	49.7	2800	46.1	4500	28.5
600	230	750	116	1400	97.6	1900	55.2	2900	49.4	5000	35.1
				1500	112	2000	61.0	3000	52.8	5500	42.5
										6000	50.5

RESISTANCE OF VALVES AND FITTINGS TO FLOW OF FLUIDS
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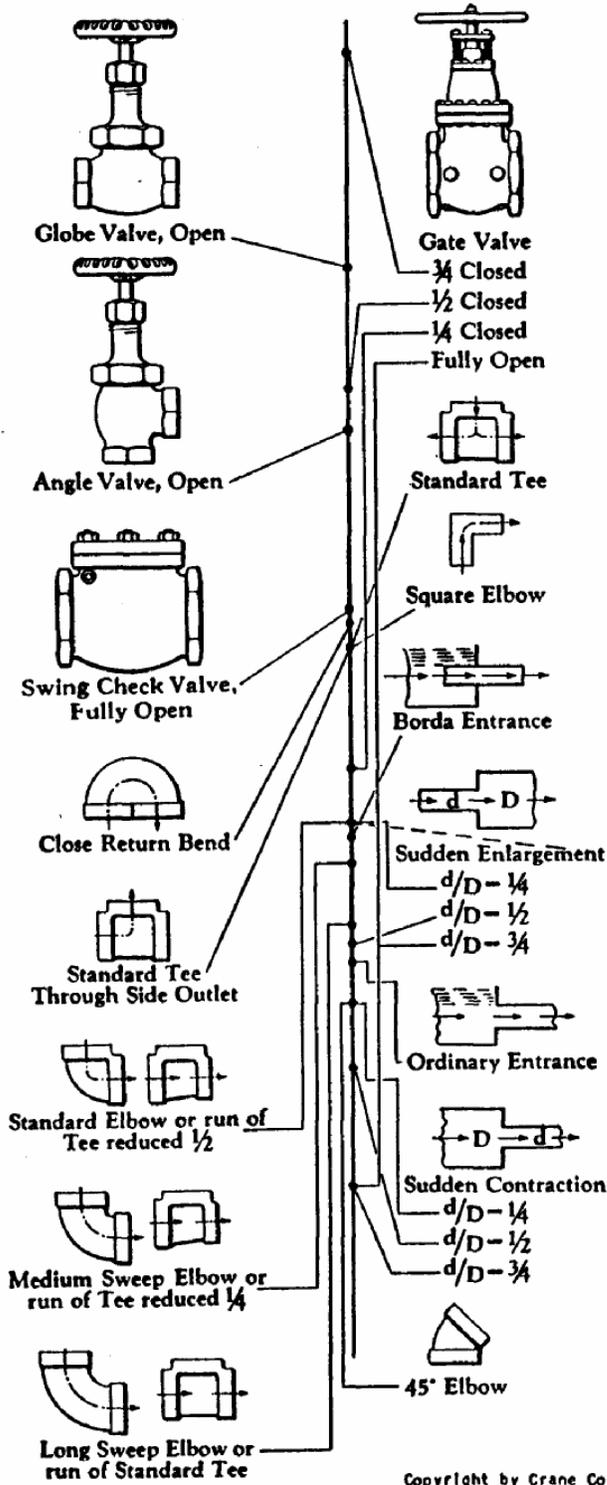
A simple way to account for the resistance offered to flow by valves and fittings is to add to the length of pipe in the line a length which will give a pressure drop equal to that which occurs in the valves and fittings in the line.

Example: The dotted line shows that the resistance of a 6-inch Standard Elbow is equivalent to approximately 16 feet of 6-inch Standard Steel Pipe.
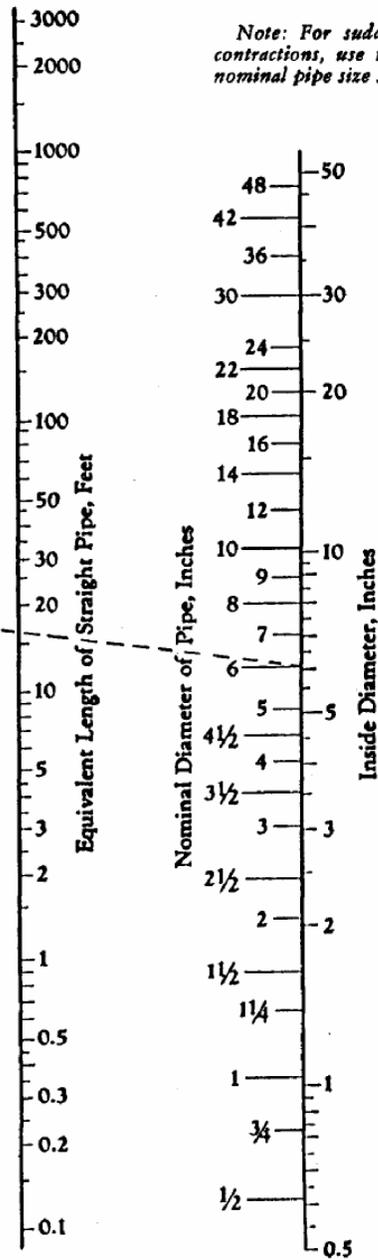
Note: For sudden enlargements or sudden contractions, use the smaller diameter on the nominal pipe size scale.

Globe Valve, Open

Angle Valve, Open

Swing Check Valve, Fully Open

Close Return Bend

Standard Tee Through Side Outlet

Standard Elbow or run of Tee reduced ½

Medium Sweep Elbow or run of Tee reduced ¼

Long Sweep Elbow or run of Standard Tee

Gate Valve
¾ Closed
½ Closed
¼ Closed
Fully Open

Standard Tee

Square Elbow

Borda Entrance

Sudden Enlargement
d/D = ¼
d/D = ½
d/D = ¾

Ordinary Entrance

Sudden Contraction
d/D = ¼
d/D = ½
d/D = ¾

45° Elbow

Equivalent Length of Straight Pipe, Feet

Nominal Diameter of Pipe, Inches

Inside Diameter, Inches

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