A pneumatic pump station for supplying water under pressure in water systems incorporating an air-gap feature to preclude backflow and water source contamination. The pump station provides a compact, easily transportable unit including a hydro-pneumatic tank, holding tank and equipment compartment arranged in a housing with a plurality of vertically extending ribs forming either an inlet channel, overflow channel or drain channel and the like. An altitude valve in the holding tank discharges inlet water on a demand basis through an air-gap defined above the water level in the holding tank. Pump means in the equipment compartment pumps water from the holding tank through a supply column extending through the pneumatic tank and delivers it into either the pneumatic tank or to the end use system.

12 Claims, 4 Drawing Figures
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PACKAGE PNEUMATIC AIR-GAP PUMP STATION
CROSS-REFERENCE TO RELATED APPLICATION


BACKGROUND OF THE INVENTION AND OBJECTS

This invention relates to water systems incorporating an air-gap feature preventing back flow from the pumping station to the source of water.

In pumping stations such as a sewage pumping plant where there is a possibility of contaminating the water supply with the sewage being pumped, governmental standards normally require that there be an air-gap between the water supply, e.g., the water supply to a municipality, and the sewage facilities. This so called air-gap takes the form of requiring a fall of water on the order of 6 inches, or perhaps in terms of a certain number of pipe diameters, from the source of water inlet to the reservoir supplying the suction side of the pumps. The result is that the pressure is lost as it is dumped from the water supply so that a pump station is required to again pump the water to the pressure required in the particular system. It is present practice to provide an air-gap water system of the above nature by separately designing and building the various items of equipment such as the air-gap tank, hydro-pneumatic tank, valves, piping, air compressor and pumps in relation to different factors such as the desired flow capacity and pressure conditions. When these elements have been selected and the plans and specifications completed, the various elements are assembled at the job site. The resulting structure is frequently very large and in separate units, difficult to maintain and operate, and susceptible to vandalism or tampering. The need has thus been recognized for a small and compact pneumatic air-gap pump station which can be inexpensively built by a manufacturer and shipped complete to an end user in response to the latter's requirements and without the necessity of custom engineering or architecture.

Accordingly, it is an object of the invention to provide a package pneumatic air-gap pump station which is easily manufactured in a small, compact unit adapted for immediate use in a water system without the requirement for custom engineering or architecture.

Another object is to provide a package pneumatic pump station for use in pumping systems where there is a requirement for a specified air-gap or waterfall between the source of water and the reservoir for the pumps.

Another object is to provide a package pneumatic pump station for use in an air-gap type pumping system which provides a compact housing containing an uppermost holding tank incorporating the inlet air-gap, a hydro-pneumatic tank in the mid-portion of the housing, and a pumping unit in the lowest portion of the housing with a supply column extending through the pneumatic tank to direct water from the holding tank to the pumping unit.

Another object is to provide a package pneumatic pump station for use in an air-gap pumping system in which a housing defining a holding tank, hydro-pneumatic tank, and equipment compartment includes a plurality of circumferentially spaced ribs one of which defines an inlet channel directing water to the holding tank, another of which defines an overflow channel, and another of which defines a drain channel.

The invention broadly includes a simplified and compact package pneumatic pump station used in pumping systems satisfying the requirement of providing a specified minimum air-gap or waterfall from the water source to the reservoir supplying water to the pumping unit. The individual elements of the station may be easily engineered by a manufacturer into a compact unit to meet the end user's requirements as to flow capacity and pressure conditions. The pump station includes a housing defining a lower equipment compartment containing the pumping unit, a hydro-pneumatic tank above the equipment compartment for containing a pressurized air pocket and

supply of water, and a holding tank above the pneumatic tank. A plurality of circumferentially arranged, vertically extending hollow ribs are positioned around the housing. One of the ribs defines an inlet channel feeding inlet water upwardly into an altitude valve discharging into the holding tank at a predetermined minimum air-gap or waterfall above the level of water in that tank. Another of the ribs defines an overflow channel to discharge an excess of water from the holding tanks. Another of the ribs defines a drain channel to empty the holding tank as required. Another of the ribs houses a water level gauge connected with the pneumatic tank. A supply column extends in sealed relationship through the pneumatic tank to direct water from the holding tank to the suction side of the pumping unit. The pumping unit delivers water under pressure into the pneumatic tank responsive to a low water level therein, and shuts down responsive to this water reaching a predetermined high water level. The pressurized air pocket forces water from the pneumatic tank through a delivery conduit to the end use system on a demand basis, assisted by water from the pump, as required.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a preferred packaged pneumatic air-gap pump station incorporating features of the invention;

FIG. 2 is a vertical cross section to an enlarged scale of the pump station of FIG. 1;

FIG. 3 is a plan view in cross section taken along the line 3-3 of FIG. 2; and

FIG. 4 is a fragmentary cross section elevational view taken along the line 4-4 of FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings and particularly FIG. 1, a package pneumatic air-gap station according to the invention is illustrated at 10. Pump station 10 has particular application in pumping systems, e.g., sewage pumping plants, where there is a possibility of contamination with a municipality's water supply and where there is a requirement for a certain specified minimum air-gap or waterfall between the water supply and the reservoir for the suction side of the pumping units.

The component elements of pump station 10 define a relatively small and compact upstanding housing 12 adapted for easy transportability to the end use site. The pump station may be rapidly installed on a suitable prepared foundation 14 which may be of concrete, crushed rock or asphalt and the like. At the installation site, it is only necessary to additionally provide suitable electrical connections and discharge connections, not shown, to the desired system. Similarly pump station 10 could be installed in a room or enclosure of a building or sewage plant.

The housing 12 of the pump station encloses a lowermost equipment bay or compartment 16, a sealed hydro-pneumatic tank 18 above the equipment compartment, and a holding tank 20 above the pneumatic tank.

Equipment compartment 16 houses pumping means 22 and is enclosed by an annular cylindrical skirt or outer wall 24. As best illustrated in FIG. 3 a plurality of access doors 26 are provided in skirt 24 permitting access to the equipment compartment for maintenance and repair. The equipment compartment 16 includes electrical control panel 28 for controlling pump operation, main service switch 30, electrical meter 32, and one or more air compressors 34, 36 supplying make-up air through air line 38 into pneumatic tank 18 to compensate for air absorbed into the contained water.

Hydro-pneumatic tank 18 comprises a cylindrical sidewall 38 enclosed by top and bottom end walls 40, 42. The tank retains a reservoir of pressurized water 43 received from and discharging through inlet/outlet fitting or branch conduit 44. The water in the pneumatic tank moves within the limits of low water level 46 and high water level 48 as determined by the rate of water consumption and resupply and as further
defined by the desired minimum pressure at the low water level and the desired maximum pressure at the high water level. The relationship between high water level and low water level must be consistent with the natural pressure-volume relationship as described in physics by “Boyle’s Law.”

Holding tank 20 is defined between a lower cylindrical skirt 50, domed top enclosure 52 and the top end wall 40 of the pneumatic tank. Epoxi filler 53 is deposited at the seam between skirt 50 and end wall 40. A hatch 54 is provided in the top enclosure to afford access to the holding tank for maintenance or repairs. The holding tank retains a reservoir of water substantially at the level 56 by means of a float or altimeter valve mechanism 58 controlling water flow through inlet opening 60 connected through conduit 62 with the source of water. The lowermost margin of inlet 60 is spaced a specified dimension, e.g. 6 inches, above a predetermined water level 56 to define a minimum air-gap or waterfall. This air-gap precludes any possible back flow of water from the holding tank into the inlet conduits which otherwise could contaminate the source of water. Altitude valve 58 is conventional and operates to open the flow through inlet 60 responsive to a reduction of water level 56 and to close flow through inlet 60 responsive to the water reaching level 56.

A plurality of circumferentially arranged, vertically extending hollow ribs 66, 68, 70, 72, 74 and 76 are provided to serve both as strengthening members for housing 12 and to define a number of functional channels. Rib 66 defines an inlet channel having a lowermost opening with an on-off valve 78 which in turn is connected through conduit 80 with a source of water, e.g. the municipality’s water system. Water under pressure flows upwardly through this channel into conduit 62 through inlet 60 under influence of altitude valve 58.

Rib 70 defines an overflow channel having an uppermost opening connected with an overflow weir 82 which is positioned at an altitude or air gap clearance below inlet 60. An overflow of water, resulting e.g. from a malfunction of altitude valve 58, flows over weir 82 and down through rib 70 to outlet 84 for discharge to the waste system, not shown.

Rib 76 defines a drain channel having an uppermost opening 86, illustrated in FIG. 4, communicating with the holding tank. An on-off valve 88 communicates with the lowest end of this drain channel and, when manually opened, functions to drain water from the holding tank to the waste system to permit maintenance and repair within the holding tank. Also, a drain valve 89 is provided in the bottom of pneumatic tank 18 to drain that tank’s water to the waste system, as required.

Rib 68 provides a channel for housing a suitable water level gauge or sight glass, not shown, communicating with pneumatic tank 18 affording a visual indication of the contained water level, and the gauge may be secured through means of a suitable locked hinge plate, not shown.

Pump means 22 comprises one or more conventional pumps such as the illustrated centrifugal pump 90 driven by electrical motor 92. The suction inlet of pump 90 is connected through conduit 94 with on-off valve 96 and a supply column 98 extending vertically through and sealed from pneumatic tank 18. The inlet end 100 of the supply column opens into the water reservoir in holding tank 20. The high pressure outlet of pump 90 is connected through discharge means comprising a Tee 102 having a branch connected into conduit 104 leading to the end use system and a branch connected through on-off valve 106 which in turn is connected with branch conduit 44 into pneumatic tank 18.

Pump motor 92 is operated under influence of a conventional control circuit including control panel 28. The control circuit energizes motor 92 for a pumping cycle responsive to sensing means, not shown, in the pneumatic tank indicating that a resupply of water is required. The sensing means is conventional and may operate responsive to either water level in tank 18, or air pressure therein which is a direct function of volume.

The tank 18 is sized in relation to the particular flow capacity requirements and pressure conditions of the water system in which the pump station will be utilized. The working volume of the tank is the volume of water between high water level 48 and low water level 46. The pump is operated by the control system when tank water drops below low level 46, and shuts down when the water is pumped into the tank above high level 48.

The use and operation of pump station 10 is as follows. Assume that pump 90 operating capacity is approximately 500 gpm. The capacity of pneumatic tank 18 is sized according to the user’s particular specifications and requirements. Assume next that in one case the fluctuating water demand of the end use system reaches 400 gpm. The control system is effective to energize motor 92 and operate pump 90 withdrawing water from the holding tank and pumping 400 gpm through discharge conduit 104 and 100 gpm through branch conduit 44 into pneumatic tank 18. When the water reaches high level 48 the control system shuts pump 90 down so that any further water demand is supplied back through conduit 44 under the pressure of the air pocket within the pneumatic tank. Indeed water is supplied into the holding tank through rib 66 under influence of altitude valve 58.

Assume for the next case that the water demand raises to 600 gpm. With 500 gpm supplied through pump 90, the remaining 100 gpm is supplied by the reverse flow from pneumatic tank 18 under the force of the pressurized air pocket.

Assume for the next case that the water demand is 150 gpm. The control system shuts pump 90 down so that, assuming that the pneumatic tank water level is between the two water levels 46 and 48, a 150 gpm flow through conduit 44 will be supplied by the pneumatic tank into the water system. This condition is maintained until the pneumatic tank water level drops sufficiently low so that the control system again operates pump 90.

While the foregoing embodiment is at present considered to be preferred it will be understood that numerous variations and modifications may be made in the details, materials and arrangement of parts by those skilled in the art and it is intended to cover in the appended claims all such variations and modifications as fall within the true spirit and scope of the invention.

1. A pump station for use in supplying water under pressure from a source of water to a water use system, including the combination of means defining a housing forming a lowest reserving compartment, a pneumatic tank positioned above the compartment for containing a reservoir of water and a pressurized air pocket, and a holding tank above said pneumatic tank for holding a volume of supply water, said housing including a plurality of circumferentially arranged, vertically extending rib means, at least one of said rib means forming an inlet channel to direct inlet water from the source of water upwardly to said holding tank, valve means to direct inlet water from said inlet channel into said holding tank to maintain a predetermined water level therein, supply conduit means having an inlet end in communication with the water in said holding tank and an outlet end, pump means in said equipment compartment, said pump means including an inlet in communication with said supply conduit outlet end and an outlet in communication with said pneumatic tank and said water use system.

2. The pump station of claim 1 in which said supply conduit means comprises at least one upright conduit extending in fluid-tight sealed relationship through said pneumatic tank from the holding tank to the equipment compartment.

3. The pump station of claim 1 in which at least another of said rib means defines an overflow channel having inlet means positioned at the level of said water in the holding tank and a lowest outlet to discharge excess water from the holding tank.

4. The pump station of claim 1 in which at least another of said rib means defines a drain channel having an inlet end in communication with said holding tank and a lowest outlet,
together with valve means to selectively drain water from said drain channel outlet.

5. The pump station of claim 1 in which said inlet channel includes water discharge means positioned in said holding tank for discharging water at a predetermined vertical gap above said holding tank water level.

6. The pump station of claim 5 in which said discharge means includes a discharge conduit in communication with said inlet channel and having an outlet positioned in said holding tank at an elevation above said holding tank water level at least equal to the dimension of said gap.

7. The pump station of claim 6 in which altitude valve means is associated with said discharge conduit outlet and opens water flow therethrough responsive to sensing a level of water in the holding tank below said predetermined level and closes flow therethrough responsive to the water level in the holding tank reaching said predetermined level.

8. A package pneumatic air-gap pump station for use in a water system for supplying water under pressure from a source of water to a water use system, including the combination of a pneumatic tank for containing a reservoir of water and a pressurized air pocket, the tank including a side wall enclosed by top and bottom end walls, an equipment compartment below said tank and including an outer wall extending below said tank bottom wall, a holding tank defined by a top enclosure and an outer wall extending above said top end wall, said holding tank adapted to contain a predetermined water level therein, water pump means in said equipment compartment and having an inlet and an outlet, a supply conduit extending in sealed relationship through said pneumatic tank and having an inlet end in communication with the water in said holding tank and an outlet end in communication with the inlet of said water pump means, conduit means to communicate water from said pump outlet into said pneumatic tank and to said water use system, and inlet means to communicate water from said source of water into said holding tank at a predetermined vertical gap above said level of water therein.

9. The pump station of claim 8 in which said inlet means includes at least one hollow rib positioned around said tank, said one rib having a lowermost inlet in communication with said source of water and an uppermost outlet discharging into said holding tank.

10. The pump station of claim 9 in which altitude valve means is provided to regulate the discharge of water through said outlet from said one rib responsive to the level of water in holding tank.

11. The pump station of claim 8 in which at least a one hollow rib is positioned around said tank and defines an overflow channel including overflow weir means positioned at a predetermined level in said holding tank to direct excess water therein downwardly through said second rib, and a lowermost outlet in said second rib to carry away said excess water.

12. The pump station of claim 11 in which control means is provided to operate said water pump means or an air compressor responsive to reduction of the water level or pressure in said pneumatic tank below a predetermined low water level or predetermined low pressure to pump water from said holding tank into the pneumatic tank, and to shut down said pump means or compressor responsive to the water level or pressure in said pneumatic tank exceeding a predetermined high water level or high pressure therein.

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