Sept. 30, 1947. DE WITT E. YATES 2,428,256

PUMPING APPARATUS

Filed March 13, 1946 2 Sheets-Sheet 1

Fig. 1

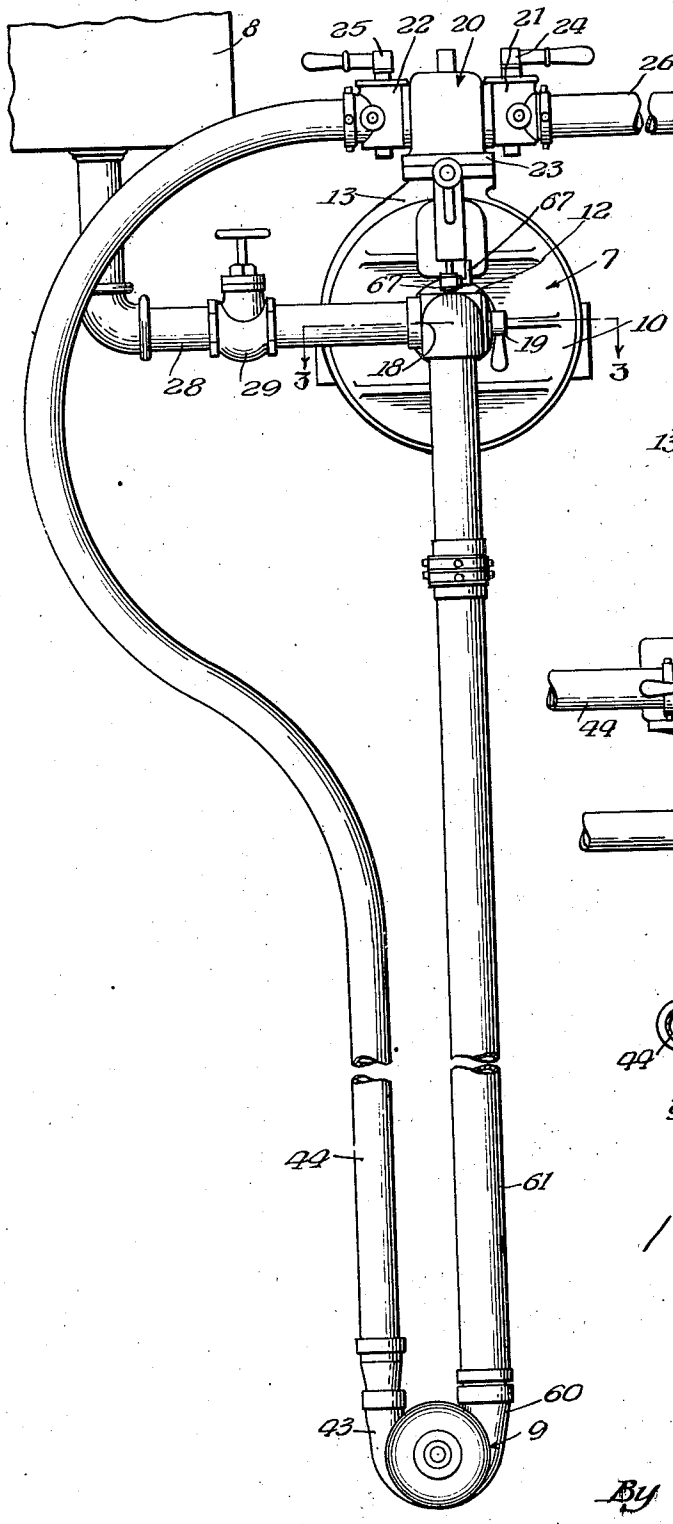


Fig. 3

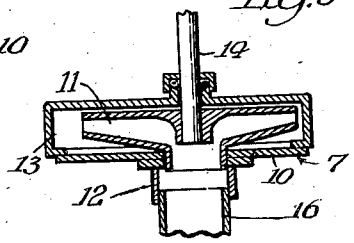
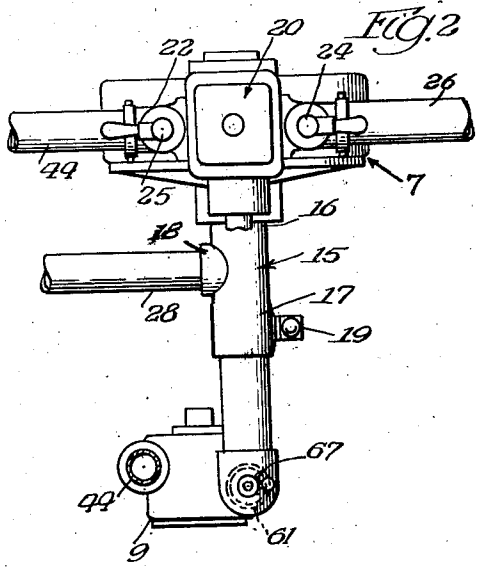


Fig. 2



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PUMPING APPARATUS

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FIG. 4

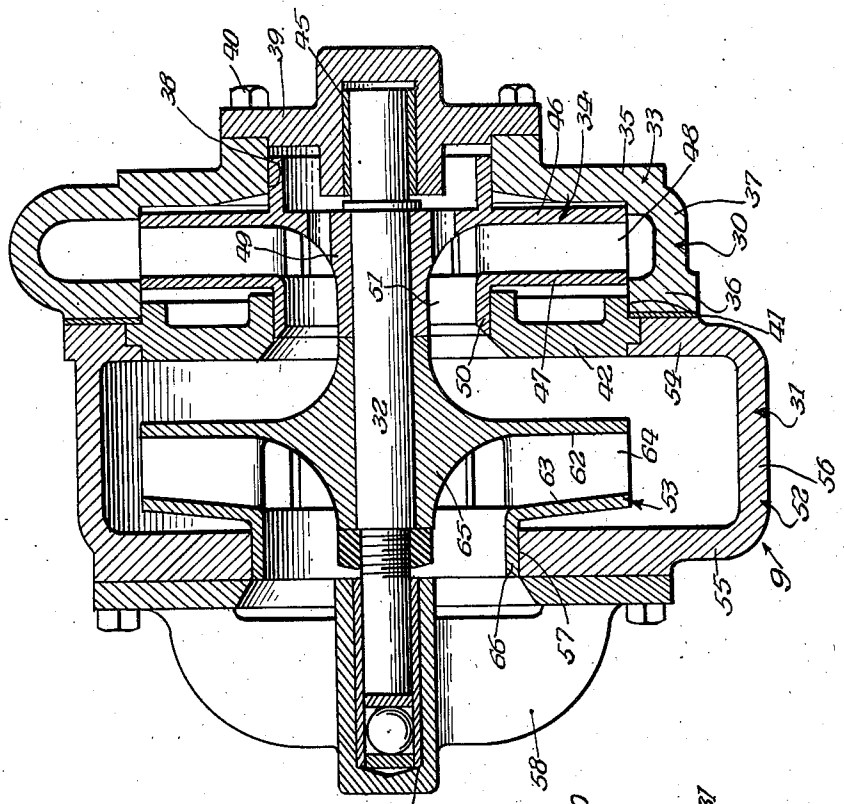


FIG. 5

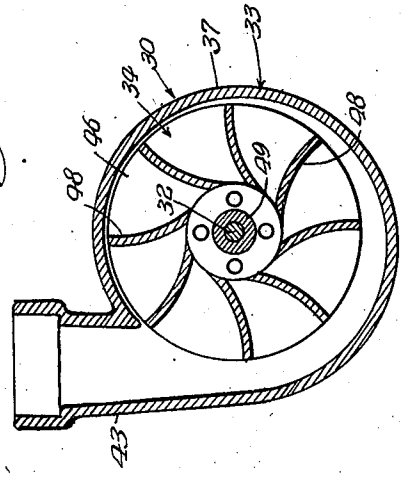
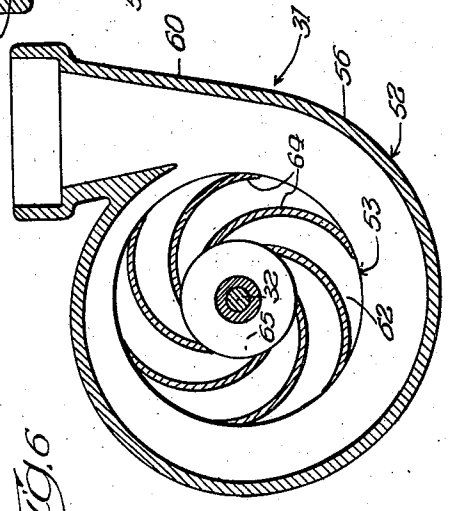


FIG. 6



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UNITED STATES PATENT OFFICE

2,428,256

PUMPING APPARATUS

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Application March 13, 1946, Serial No. 653,976

10 Claims. (Cl. 103—113)

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The present invention relates generally to pumping apparatus. More particularly the invention relates to that type of pumping apparatus which is primarily designed and adapted to pump water from a low level body of water to a height an appreciable distance above the height of the body and as its main or principal components comprises: (1) a main centrifugal pump which is located an appreciable distance above the body of water and has power means for driving it; and (2) a combined turbine and centrifugal booster pump which is in the form of a self-contained unit, is adapted to be immersed in the body of water, has a common drive shaft on which the rotor of the turbine and the impeller of its centrifugal pump are fixedly secured, and, in addition, has the inlet of the casing for the turbine connected by a small sized or branch conduit to the outlet of the casing of the main centrifugal pump and the outlet of the casing of its centrifugal booster pump connected to the inlet of the main centrifugal pump, and serves in connection with drive of the main centrifugal pump after priming of the latter to boost or pump water from the body of water into the inlet of the casing of the main centrifugal pump.

One object of the invention is to provide a pumping apparatus of this type which is an improvement upon, and has certain inherent advantages over, previously designed pumping apparatus for the same purpose and is characterized by high operating efficiency.

Another object of the invention is to provide a pumping apparatus of the type under consideration which comprises a T fitting having one branch thereof connected to the outlet of the casing of the main centrifugal pump, another of its branches provided with a valve for control purposes and connected to a main discharge conduit, and the third branch thereof provided with a valve and connected to the inlet end of the small sized or branch conduit that leads to the inlet of the casing for the turbine of the combined turbine and centrifugal booster pump.

Another object of the invention is to provide a pumping apparatus of the last mentioned character which comprises as a medium for priming the main centrifugal pump in connection with starting of the apparatus, a make-up water tank which is disposed above the main centrifugal pump and is connected to the inlet of the casing of the main centrifugal pump by way of a valve equipped conduit.

Another object of the invention is to provide a pumping apparatus of the last mentioned character in which the discharge end of the conduit that leads from the make-up water tank is connected to the discharge end of the conduit that leads from the outlet of the casing of the centrifugal booster pump, and the discharge end of the latter conduit embodies a valve ahead of the discharge end of the conduit that leads from the make-up water tank in order that in connection with a main pump priming operation it is possible to cut off or prevent the flow of water from the make-up water tank to the centrifugal booster pump.

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A further object of the invention is to provide a pumping apparatus of the type and character under consideration in which the conduits between the main centrifugal pump and the combined turbine and centrifugal booster pump are flexible to the end that the combined turbine and centrifugal booster pump may be readily moved with respect to the main centrifugal pump.

A still further object of the invention is to provide a pumping apparatus which is generally of new and improved construction and may be constructed at a comparatively low cost.

Other objects of the invention and the various advantages and characteristics of the present pumping apparatus will be apparent from a consideration of the following detailed description.

The invention consists in the several novel features which are hereinafter set forth and are more particularly defined by claims at the conclusion hereof.

In the drawings which accompany and form a part of this specification or disclosure and in which like numerals of reference denote corresponding parts throughout the several views:

Figure 1 is a fragmentary side view of a pumping apparatus embodying the invention;

Figure 2 is a fragmentary plan view of the apparatus, illustrating in detail the manner in which the discharge end of the conduit that leads from the outlet of the casing of the centrifugal booster pump and the discharge end of the conduit that leads from the bottom of the make-up water tank are connected to the inlet of the casing of the main centrifugal pump;

Figure 3 is a horizontal section taken on the line 3—3 of Figure 1 omitting certain elements and showing the construction and design of the main centrifugal pump and the manner in which it is driven;

Figure 4 is an enlarged horizontal section of the combined turbine and centrifugal booster pump;

Figure 5 is a reduced vertical transverse section

of the turbine of the combined turbine and centrifugal booster pump; and

Figure 6 is a reduced vertical transverse section of the centrifugal booster pump.

The pumping apparatus which is shown in the drawings constitutes the preferred form or embodiment of the invention. It is designed and adapted to pump or elevate water from a low level body of water W and has special utility or capability of use as part of a fire fighting apparatus (not shown) of the type that comprises an automotive variety truck and is used in rural communities where there is no installation of high pressure water systems. As its principal components or parts the subject pumping apparatus comprises a main centrifugal pump 7, a make-up water tank 8 and a combined turbine and centrifugal booster pump 9. It is contemplated that when the pumping apparatus is used as a part of a fire fighting apparatus of the aforementioned type the main centrifugal pump 7 and the make-up water tank 8 will be mounted on the chassis or body of a truck variety vehicle and also that in connection with a fire fighting operation the combined turbine and centrifugal booster pump, which, as hereinafter described more in detail, is connected to the main centrifugal pump by flexible conduits, will be immersed in a lake, well or other source of water. The subject apparatus has special utility in instances where the automotive type truck on which the main centrifugal pump and the make-up water tank are mounted is located above the source or body of water to be pumped a distance greater than that to which water may be elevated or pumped by suction.

The main centrifugal pump 7 comprises a volute casing 10 and a closed variety impeller 11. The casing 10 is of conventional design or construction, embodies an inlet 12 in the central portion of its front wall and has a substantially tangential outlet 13 in the portion of its side wall that has the greatest or maximum radius. Preferably the casing 10 of the main centrifugal pump is arranged so that the axis thereof is horizontal. The impeller 11 is suitably rotatably mounted within the volute casing 10 and embodies spaced apart front and rear shrouds and an annular series of blades between the two shrouds. It is driven by way of a horizontal drive shaft 14 which extends through a stuffing box in the central portion of the rear wall of the casing 10 and is connected for drive by a prime mover (not shown), such, for example, as the internal combustion engine of the automotive type truck on which the main centrifugal pump and the make-up water tank are mounted. When the main centrifugal pump is driven by its prime mover the impeller 11 operates to draw or suck water into the casing 10 via the inlet 12 and then through the action of its blades to fling the water outwards under pressure so that it travels around the side wall of the casing and is finally discharged through the tangential outlet 13, as well understood in the art. The inlet 12 of the casing 10 of the main centrifugal pump 7 has associated with it a T fitting 15, comprising a pair of longitudinal or aligned branches 16 and 17 and a transverse branch 18. The latter is connected to, and communicates with, the inner ends of the two longitudinal branches. The longitudinal branch 16 is connected to the inlet 12 in the central portion of the front wall of the pump casing 10 and the other longitudinal branch of the T fitting 15, i. e., the branch 17, is provided with a control valve 19. The tangential outlet 13 of the pump casing 10 has associated with it a T fitting 20 and this comprises a pair of longitudinal or aligned branches 21 and 22 and a transverse branch 23. The latter branch is suitably connected to the outlet 13 and is connected to, and communicates with, the inner ends of the longitudinal branches 21 and 22. The longitudinal branch 21 of the T fitting 20 is provided with a control valve 24 and the longitudinal branch 22 is provided with a control valve 25. A flexible conduit 26 in the form of a hose is connected to, and leads from, the outer end of the longitudinal branch 21 of the T fitting 20 and is provided at its outer end with a nozzle 27. When the main centrifugal pump 7 is in operation while the valves 24 and 25 are partially or fully open a portion of the water that is discharged from the pump via the tangential outlet 13 flows through the flexible nozzle equipped conduit 26 and the balance flows through the longitudinal branch 22 of the T fitting 20.

The make-up water tank 8 serves as a medium for priming the main centrifugal pump 7 in connection with starting or initial operation of the latter. It is disposed above the main pump 7 and is adapted to contain a column or body of water. The bottom of the make-up water tank 8 is connected to the transverse branch 18 of the T fitting 15 by way of a conduit 28. The latter is preferably in the form of a composite pipe and embodies a valve 29. When it is desired to prime the main centrifugal pump 7 in connection with starting of the latter the valve 19 in the longitudinal branch 17 of the T fitting 15 is closed and the valve 29 is opened. Upon opening of the last mentioned valve water flows by gravity from the make-up water tank 8 into the central portion of the impeller 11 via the inlet 12 in the central portion of the front wall of the pump casing 10. In connection with a main pump priming operation the valve 24 in the longitudinal branch 21 of the T fitting 20 is closed and the valve 25 in the branch 22 of said fitting is fully opened for reasons or purposes that are described hereafter. After complete priming of the pump the valve 29 is closed and the valve 19 is opened. In addition the valve 24 is opened either partially or fully.

The combined turbine and centrifugal booster pump 9 serves to boost or pump water from the body of water W to the main centrifugal pump 7 during drive or operation of the latter. It is essentially a self-contained unit and in connection with use thereof is adapted to be fully immersed in the body of water W. As its main or principal components the combined turbine and centrifugal booster pump comprises a turbine 30, a centrifugal booster pump 31 and a shaft 32.

The turbine 30 is of the inward flow type or variety and comprises a volute casing 33 and a rotor 34 in the casing. The casing 33 consists of an outer end wall 35, an inner end wall 36 and a side wall 37. The outer end wall 35 of the turbine casing 33 embodies a centrally disposed comparatively large hole 38 and this is normally closed by a circular cap 39 which is removably secured in place by an annular series of bolts 40. The inner end wall 36 of the turbine casing 33 is disposed in spaced relation with the outer end wall 35 and has an extremely large centrally disposed circular hole 41 which surrounds a ring shaped partition 42. The side wall 37 of the turbine casing 33 is spiral or volute in form and extends between, and is connected to, the outer margins of the outer and inner end walls 35 and 36.

A tangential nipple 43 is connected to, and formed integrally with, the portion of the side wall 37 that is of maximum radius and forms the inlet for the turbine casing 33. Preferably the combined turbine and centrifugal booster pump is arranged so that during use thereof the shaft 32 extends horizontally and the inlet forming nipple 43 projects upwards, as shown in Figure 1. The outer or receiving end of the nipple 43 is connected by a flexible branch conduit 44 to the longitudinal branch 22 of the T fitting 20 and is connected to the tangential outlet 13 of the casing 10 of the main centrifugal pump 7. It is contemplated that when the main pump is in operation the valve 25 in the T fitting branch 22 will be partially or fully opened in order that a portion of the pumped water or pumpage will flow into and through the flexible conduit 44. The portion of the pumped water that flows through the conduit 44 enters the turbine casing 33 via the tangential inlet forming nipple 43 and flows or swirls around the volute side wall 37 in the form of an arc of decreasing radius. Preferably the conduit 44 is in the form of a noncollapsible hose. It is of such length that the combined turbine and centrifugal booster pump may be positioned or located at an appreciable distance from the main centrifugal pump 7.

The shaft 32 is disposed in concentric relation with respect to the turbine casing 33 and is arranged so that one end part thereof projects into the interior of the turbine casing through the hole in the ring shaped partition 42. The outer extremity of said one end part of the shaft 32 is journalled in a bearing 45 on the central portion of the cap 39.

The rotor 34 of the turbine is disposed in the casing 33 and consists of a circular outer shroud 46, a circular inner shroud 47 and an annular series of arcuate blades 48 between the two shrouds. The outer shroud 46 is provided with an inwardly extending, inwardly tapered hub 49 which extends around and is keyed or otherwise fixedly secured to the end of the shaft 32 that is disposed in the turbine casing 33. The inner shroud 47 of the turbine rotor embodies on the central portion thereof an inwardly extending cylindrical sealing ring 50 which is rotatably mounted within the inner periphery of the ring shaped partition 42 and forms an annular outlet 51. The blades 48 between the outer and inner shrouds are arranged so that the inner ends thereof terminate adjacent the sealing ring. They are so angularly disposed with respect to the center of the turbine rotor that when water under pressure is introduced into the casing 33 via the nipple 43 the water impinges against them, is directed inwards and produces rotation of the rotor 34 and the shaft 32. The water after travelling inwards past the blades flows out of the turbine casing 33 through the annular outlet 51.

The centrifugal booster pump 31 is positioned in side by side relation with the turbine 30 and comprises a volute casing 52 and a closed variety impeller 53. The casing 52 consists of an inner end wall 54, an outer end wall 55, and a side wall 56. The inner end wall 54 fits against, and is bolted or otherwise fixedly secured to, the inner end wall 36 of the turbine casing 33 and has a central large sized hole which surrounds a portion of the outer periphery of the ring shaped partition 42. As shown in Figure 4 of the drawings the outlet 51 of the turbine is in communication with the central portion of the interior of the pump casing 52. The outer end wall 55 of

the pump casing 52 is disposed in laterally spaced relation with the inner end wall 54 and embodies a centrally disposed circular hole 57 which defines a central water inlet for the centrifugal booster pump 31. A spider 58 is bolted or otherwise fixedly secured to the outer face of the outer end wall 55. This spider carries on the hub or central portion thereof a bearing 59. The other end of the shaft 32, i. e., the end that is opposite the end on which the rotor 34 of the turbine is mounted, extends through the central portion of the booster pump casing 52 and has its outer extremity journalled in the bearing 59. The side wall 56 of the booster pump casing 52 is volute or spiral in form and extends between, and is connected to, the outer margins of the inner and outer end walls 54 and 55. A tangentially extending nipple 60 is connected to, and formed integrally with, the portion of the casing side wall 56 that is of maximum radius and forms the pump outlet. As shown in Figure 4, the nipple 60 extends in the same direction as the nipple 43 and is located on the opposite side of the shaft 32. The nipple 60 is connected by a flexible conduit 61 to the longitudinal valve equipped branch 17 of the T fitting 15. Said conduit is of larger size or diameter than the small sized branch conduit 44 and is preferably in the form of a noncollapsible hose. When the combined turbine and centrifugal booster pump is in operation the water which is pumped by the booster pump flows upwards through the flexible conduit 61 into the inlet 12 of the casing 10 of the main power driven centrifugal pump 7.

The impeller 53 of the centrifugal booster pump 31 comprises an inner shroud 62, an outer shroud 63 and an annular series of arcuate blades 64 between the two shrouds and is positioned between, and in spaced relation with, the inner and outer end walls 54 and 55 of the pump casing 52. The inner shroud 62 is provided at the central portion thereof with an axially elongated hub 65 and this is keyed or otherwise fixedly secured to the adjacent portion of the shaft 32. The outer shroud 61 of the pump impeller 53 is provided with a centrally disposed outwardly extending cylindrical sealing ring 66 which fits rotatably within the circular hole 57 constituting the inlet for the booster pump casing 52. When the centrifugal booster pump is in operation as the result of drive of the turbine rotor, water is drawn or sucked into the central portion of the impeller interior through the sealing ring 66 and is then flung outwards under pressure by the blades 64 against the side wall 56 of the pump casing. Because of the shape or the volute character of the side wall the water travels around the side wall and is then discharged via the tangential discharge nipple 60. For a more detailed description of the construction, design and mode of operation of the combined turbine and centrifugal booster pump 9 reference may be had to my copending patent application Serial No. 634,647, filed December 13, 1945.

When it is desired to use the pumping apparatus the combined turbine and centrifugal booster pump 9 is first immersed in the body of water W. Thereafter the valves 19 and 24 are closed and the main centrifugal pump 7 is placed in operation by starting the prime mover therefor. As soon as the main centrifugal pump is in operation the valve 29 is opened so as to cause the water in the tank 8 to flow into the casing 12 of the pump 7. The water which is delivered to the main pump casing 10 by the make-up water

tank 8 is delivered under pressure via the small sized branch conduit 44 into the turbine casing 33 and results in conjoint drive of the turbine rotor 34 and the booster pump impeller 53. As soon as the booster pump is set in operation it operates to draw the water W from the body in which the combined turbine and centrifugal booster pump is immersed and forces the water up under pressure through the flexible conduit 61 to the T fitting 15. A pet cock 67 is connected to the longitudinal branch 17 of the T fitting 15 at a point ahead of the valve 19 and this in connection with starting of the apparatus is opened. As soon as water under pressure flows out of the pet cock and indicates that there is water under pressure adjacent the inlet of the casing of the main centrifugal pump the valve 29 is closed and the valves 19 and 24 are opened. Such manipulation of the valves results in the water that is pumped by the centrifugal booster pump entering the casing 10 of the main centrifugal pump 7 and being pumped by the impeller of the main pump partly through the nozzle equipped discharge conduit 26 and partly back to the casing 33 of the turbine 30 via the flexible conduit 44. As soon as the valve 29 is closed and the valves 19 and 24 are opened the pet cock 67 is closed. Should it be desired to refill the make-up water tank 8 while the pumping apparatus is in operation the valve 29 is opened so that a portion of the water that is pumped by the centrifugal booster pump to the casing of the main centrifugal pump flows into and serves to fill the make-up water tank 8.

The herein described pumping apparatus has high operating efficiency and may be controlled and operated with facility. It is comparatively simple in design and hence is capable of being produced at a comparatively low cost. As heretofore pointed out, the apparatus has special utility as a piece or part of fire fighting equipment.

Whereas the apparatus has been described as having special use in connection with an automotive variety fire truck for use in rural districts where high pressure water systems are not available it is to be understood that the apparatus has other capabilities of use in that it may be used to good advantage in any instance where it is desired to pump water from a low level to an appreciable higher level. It is also to be understood that the invention is not to be restricted to the details set forth since these may be modified within the scope of the appended claims without departing from the spirit and scope of the invention.

Having thus described the invention what I claim as new and desire to secure by Letters Patent is:

1. An apparatus adapted to pump from a body of liquid to a point an appreciable distance above the body and comprising a main centrifugal pump disposed above the body, provided with means for driving the impeller thereof and having for its casing an inlet and a two branch outlet with a control valve in each branch, a combined turbine and centrifugal booster pump adapted to be immersed in the body of liquid, provided with a common shaft on which the rotor of the turbine and the impeller of its centrifugal booster pump are mounted, and having the outlet of the casing for the turbine communicating with the interior of the casing for its centrifugal booster pump, a conduit extending between, and connected to, one of said branches and the inlet of the casing for the turbine, and a conduit of larger size than the first mentioned conduit extending between, and connected to, the outlet of the casing for the centrifugal booster pump and the inlet of the casing for the main centrifugal pump.

2. An apparatus adapted to pump from a body of liquid to a point an appreciable distance above the body and comprising a main centrifugal pump disposed above said body, provided with means for driving the impeller thereof and embodying a volute casing with a central inlet in one of its end walls and a tangential outlet in the portion of its side wall that is of maximum radius, a fitting connected to, and communicating with, the tangential outlet and provided with a pair of valve equipped outlet branches, an outlet conduit connected to one of the branches, a combined turbine and centrifugal booster pump adapted to be immersed in the body of liquid, provided with a common shaft on which the rotor of the turbine and the impeller of its centrifugal booster pump are mounted, and having the outlet of the casing for the turbine communicating with the interior of the casing for its centrifugal booster pump, a small sized conduit extending between, and connected to, the other branch of the fitting and the inlet of the casing for the turbine, and a larger sized conduit extending between, and connected to, the outlet of the casing for the centrifugal booster pump and the inlet of the main centrifugal pump casing.

3. An apparatus adapted to pump from a body of liquid to a point an appreciable distance above the body and comprising a main centrifugal pump disposed above said body, provided with means for driving the impeller thereof and embodying a volute casing with a central inlet in one of its end walls and a tangential outlet in the portion of its side wall that is of maximum radius, a T fitting having the transverse branch thereof connected to, and communicating with said tangential outlet and provided with a valve for each of its longitudinal branches, an outlet conduit connected to one of the longitudinal branches of the T fitting, a combined turbine and centrifugal booster pump adapted to be immersed in the body of liquid, provided with a common shaft on which the rotor of the turbine and the impeller of its centrifugal booster pump are mounted, and having the outlet of the casing for the turbine communicating with the interior of the casing for its centrifugal booster pump, a small sized conduit extending between, and connected to, the other longitudinal branch of the T fitting and the inlet of the casing for the turbine and a larger size conduit extending between, and connected to, the outlet of the casing for the centrifugal booster pump and the inlet of the main centrifugal pump casing.

4. An apparatus adapted to pump from a body of liquid to a point an appreciable distance above the body and comprising a main centrifugal pump disposed above the body, provided with means for driving the impeller thereof and having for its casing an inlet and a two branch outlet with a control valve in each branch, a combined turbine and centrifugal booster pump adapted to be immersed in the body of liquid, provided with a common shaft on which the rotor of the turbine and the impeller of its centrifugal booster pump are mounted, and having the outlet of the casing for the turbine communicating with the interior of the casing for its centrifugal booster pump, a flexible conduit extending between, and connected to, one of the branches of the outlet for the casing of the main

centrifugal pump and the inlet of the casing for the turbine, and a flexible conduit of larger size than the first mentioned conduit extending between, and connected to, the outlet of the casing for the centrifugal booster pump and the inlet of the casing for the main centrifugal pump.

5. An apparatus adapted to pump from a body of water to a point an appreciable distance above the body and comprising a main centrifugal pump disposed above the body, provided with means for driving the impeller thereof, and embodying a casing with an inlet and a two branch outlet with a control valve in each branch, a priming tank for the apparatus disposed adjacent the main centrifugal pump, adapted to contain a body of make-up water, and having the bottom thereof connected to the inlet of the casing for said main centrifugal pump by a valve controlled conduit, a combined turbine and centrifugal booster pump adapted to be immersed in the body of water, provided with a common shaft on which the rotor of the turbine and the impeller of its centrifugal booster pump are mounted, and having the outlet of the casing for the turbine communicating with the interior of the casing for its centrifugal booster pump, a conduit extending between, and connected to, one of the branches of the outlet of the casing for the main centrifugal pump and the inlet of the casing for the turbine, and a conduit of larger size than the last mentioned conduit extending between, and connected to, the outlet of the casing for the centrifugal booster pump and said inlet of the casing for said main centrifugal pump.

6. An apparatus adapted to pump from a body of water to a point an appreciable distance above the body and comprising a main centrifugal pump disposed above the body, provided with means for driving the impeller thereof and embodying a casing with an inlet and a two branch outlet with a control valve for each of the branches thereof, a priming tank for the apparatus disposed above the main centrifugal pump, adapted to contain a body of water and having the bottom portion thereof connected to the inlet of the casing for said main centrifugal pump by a valve controlled conduit in order that the water therein upon opening of the last mentioned valve will flow by gravity into the main pump casing, a combined turbine and centrifugal booster pump adapted to be immersed in the body of water, provided with a common shaft on which the rotor of the turbine and the impeller of its centrifugal booster pump are mounted, and having the outlet of the casing for the turbine communicating with the interior of the casing for its centrifugal booster pump, a conduit extending between, and connected to, one of the branches of the outlet of the casing for the main centrifugal pump and the inlet of the casing for the turbine, and a conduit of larger size than the last mentioned conduit extending between, and connected to, the outlet of the casing for the centrifugal booster pump and said inlet of said casing for said main centrifugal pump.

7. An apparatus adapted to pump from a body of water to a point an appreciable distance above the body and comprising a main centrifugal pump disposed above the body, provided with means for driving the impeller thereof, and embodying a casing with an inlet and a two branch outlet with a control valve in each branch, a priming tank for the apparatus disposed adjacent the main centrifugal pump, adapted to contain a body of make-up water, and having the bottom thereof connected to the inlet of the casing for said main centrifugal pump by a valve controlled conduit, a combined turbine and centrifugal booster pump adapted to be immersed in the body of water, provided with a common shaft on which the rotor of the turbine and the impeller of its centrifugal booster pump are mounted, and having the outlet of the casing for the turbine communicating with the interior of the casing for its centrifugal booster pump, a conduit extending between, and connected to, one of the branches of the outlet for the casing of the main centrifugal pump and the inlet of the casing for the turbine, and a conduit of larger size than the last mentioned conduit having one end thereof connected to the outlet of the casing for the centrifugal booster pump and its other end connected to said inlet of the casing for said main centrifugal pump and provided with a control valve.

8. An apparatus adapted to pump from a body of water to a point an appreciable distance above the body and comprising a main centrifugal pump disposed above said body, provided with means for driving the impeller thereof, and embodying a casing with an inlet and a two branch outlet with a control valve in each branch, a T fitting having one of the longitudinal branches thereof connected to said inlet and its other longitudinal branch provided with a valve, a priming tank for the apparatus disposed adjacent the main centrifugal pump, adapted to contain a body of water and having the bottom portion thereof connected to the transverse branch of said T fitting by a valve controlled conduit, a combined turbine and centrifugal booster pump adapted to be immersed in the body of water, provided with a common shaft on which the rotor of the turbine and the impeller of its centrifugal booster pump are mounted, and having the outlet of the casing for the turbine communicating with the interior of the casing for its centrifugal booster pump, a conduit extending between, and connected to, one of the branches of the outlet for the casing of the main centrifugal pump and the inlet of the casing for the turbine, and a conduit of larger size than the last mentioned conduit extending between, and conected to, the outlet of the casing for the centrifugal booster pump and said inlet of the casing for said main centrifugal pump.

9. An apparatus adapted to pump from a body of water to a point an appreciable distance above the body and comprising a main centrifugal pump disposed above said body, provided with means for driving the impeller thereof, and embodying a volute casing with an inlet in the central portion of one of its end walls and a tangential outlet in the portion of its side wall that is of maximum radius, a fitting connected to the outlet and provided with a pair of discharge branches, one of which has a control valve therein, means for priming the apparatus embodying a conduit provided with a control valve therefor and having one end thereof connected to a source of water and its other end connected to the inlet of the main pump casing, a self-contained combined turbine and centrifugal booster pump adapted to be immersed in the body of water, having the casings of the turbine and booster pump thereof arranged in side by side relation, provided with a common shaft on which the rotor of the turbine and the impeller of its centrifugal

booster pump are mounted, and having the outlet of the casing for the turbine communicating with the interior of the casing for its centrifugal booster pump, a flexible conduit extending between, and connected to, the other branch of the fitting and the inlet of the casing for the turbine, and a flexible conduit of larger size than the first mentioned conduit, extending between, and connected to, the outlet of the casing for the centrifugal booster pump and said inlet of the casing for said main centrifugal pump.

10. An apparatus adapted to pump from a body of water to a point an appreciable distance above the body and comprising a main centrifugal pump disposed above the body, provided with means for driving the impeller thereof, and embodying a volute casing with an inlet in the central portion of one of its end walls and a tangential outlet on the portion of its side wall that is of maximum radius, a T fitting having one of the longitudinal branches thereof connected to said inlet and its other longitudinal branch provided with a control valve, a second T fitting having the transverse branch thereof connected to, and in communication with, the tangential outlet and its longitudinal branches each provided with a control valve, an outlet conduit connected to, and leading from, one of the longitudinal branches of said second T fitting, a priming tank for the apparatus disposed adjacent the main centrifugal pump, adapted to contain a body of water, and having the bottom thereof connected to the transverse branch of the first mentioned T fitting by a valve controlled conduit, a self-contained combined turbine and centrifugal booster pump adapted to be immersed in the body of water, having the casings of the turbine and centrifugal booster pump thereof arranged in side by side relation, provided with a common shaft on which the rotor of the turbine and the impeller of its centrifugal booster pump are mounted, and having the outlet of the casing for the turbine communicating with the interior of the casing for its centrifugal booster pump, a flexible conduit extending between, and connected to, the other longitudinal branch of said second T fitting and the inlet of the casing for the turbine, and a flexible conduit of larger size than the last mentioned conduit extending between, and connected to, the outlet of the casing for the centrifugal booster pump and the valve equipped longitudinal branch of said first mentioned T fitting.

DE WITT E. YATES.

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Number	Name	Date
1,610,454	Lawaczeck	Dec. 14, 1926
1,982,841	Tamini	Dec. 4, 1934