

July 25, 1950

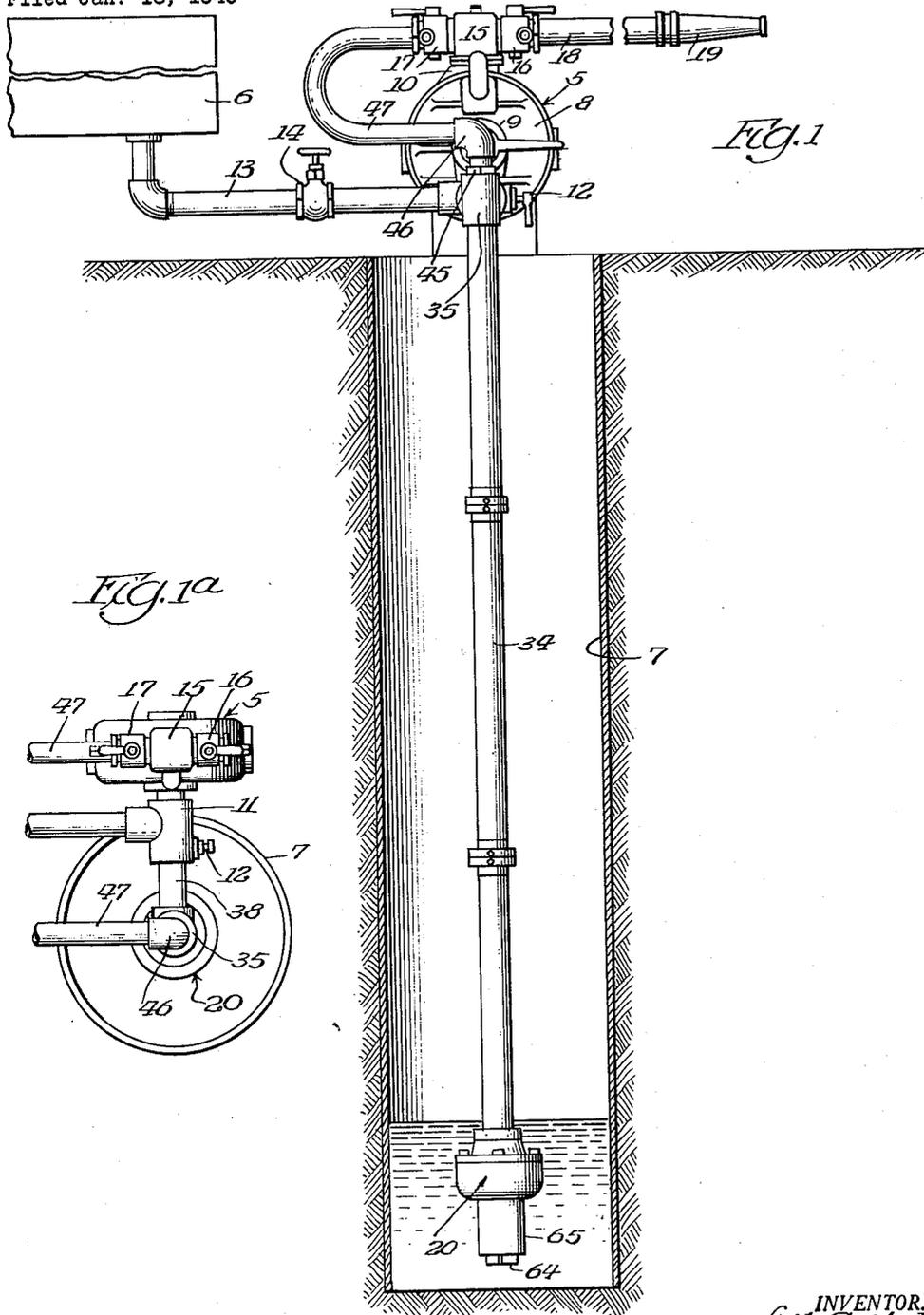
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2,516,822

COMBINED TURBINE AND CENTRIFUGAL BOOSTER PUMP

Filed Jan. 18, 1946

3 Sheets-Sheet 1



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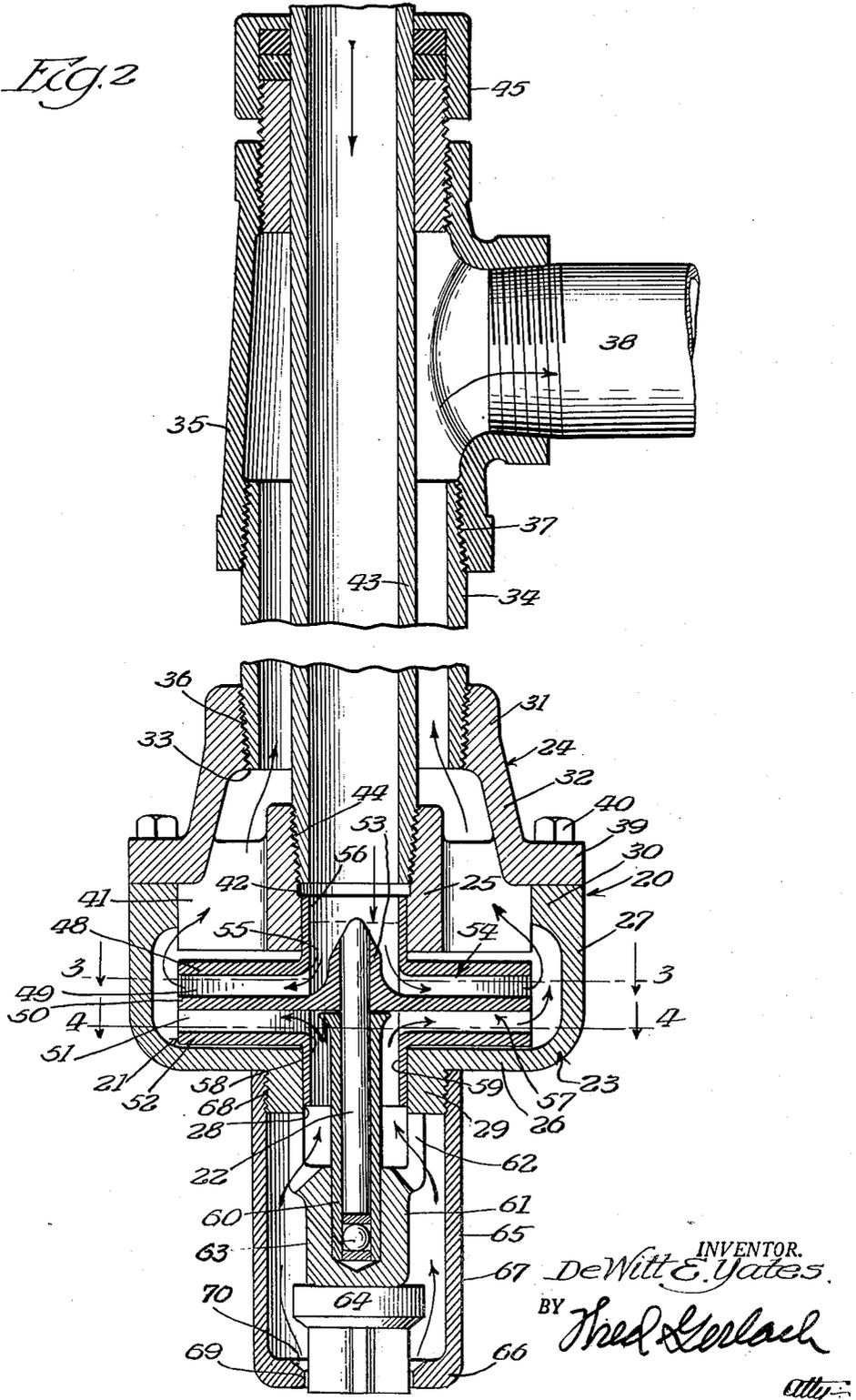
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3 Sheets-Sheet 2

Fig. 2



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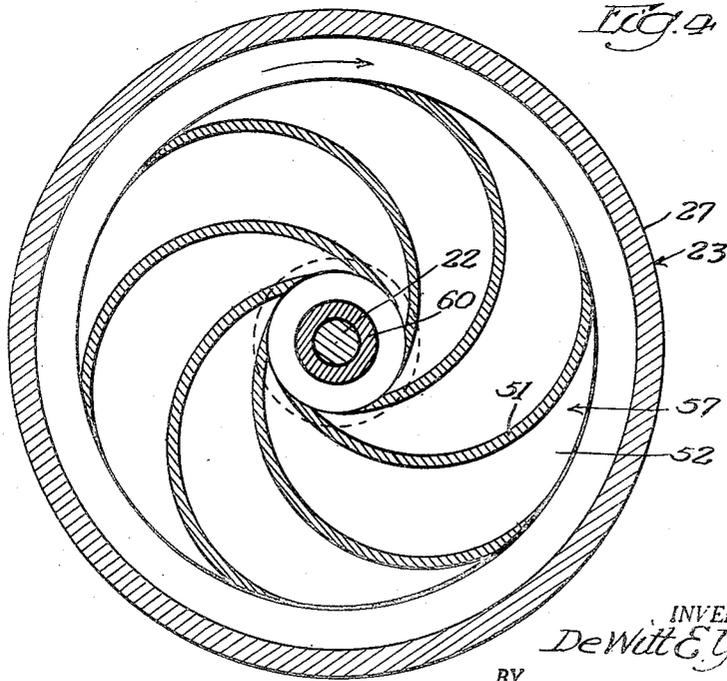
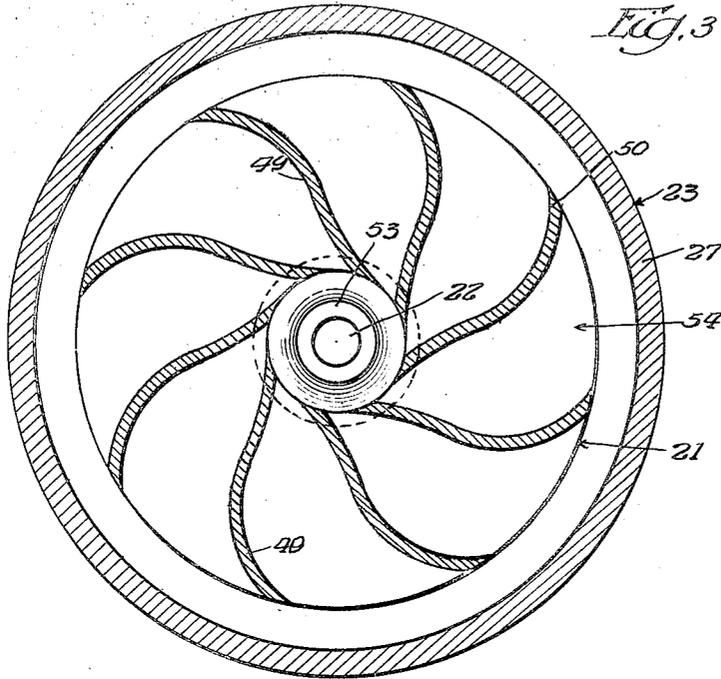
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COMBINED TURBINE AND CENTRIFUGAL BOOSTER PUMP

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

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COMBINED TURBINE AND CENTRIFUGAL BOOSTER PUMP

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Application January 18, 1946, Serial No. 642,023

2 Claims. (Cl. 103-87)

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The present invention relates generally to combined turbines and centrifugal booster pumps. More particularly the invention relates to that type of combined turbine and centrifugal booster pump which is adapted for use in connection with a power driven main centrifugal pump at an appreciable height or elevation above a source of water, has a common shaft on which the rotor of the turbine and the impeller of its centrifugal pump are mounted, and in addition, has the inlet 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 its centrifugal pump connected to the inlet of the casing of the main centrifugal pump, and serves when immersed in the source of water and in connection with drive of the main pump to pump water from the source into the inlet of the casing of the main centrifugal pump.

One object of the invention is to provide a combined turbine and centrifugal booster pump of this type which is an improvement upon, and has certain advantages over, previously designed combined turbines and centrifugal booster pumps and is characterized by compactness as well as simplicity of design and high operating efficiency.

Another object of the invention is to provide a combined turbine and centrifugal booster pump in which the various component parts thereof are arranged and constructed in a novel manner to the end that the unit as a whole has not only high operating efficiency but also long life.

Another object of the invention is to provide a combined turbine and centrifugal booster pump of the type under consideration in which the turbine is of the outward flow variety and discharges directly into the pumpage from the impeller of the centrifugal booster pump.

Another object of the invention is to provide a combined turbine and centrifugal booster pump which comprises but a single casing for the turbine and booster pump and in which the rotor of the turbine and the impeller of the booster pump are formed integrally with one another.

A further object of the invention is to provide a combined turbine and centrifugal booster pump which is especially designed and adapted to pump water from a deep water well having a comparatively small sized casing, and in which the branch or small sized conduit leading from the outlet of the power driven main centrifugal pump to the turbine inlet is disposed within, and

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arranged in concentric relation with, the conduit that leads from the outlet of the booster pump to the inlet of the main centrifugal pump.

A still further object of the invention is to provide a combined turbine and centrifugal booster pump which is generally of new and improved construction and, due to the arrangement and design of its component parts, may be produced at a comparatively low cost.

Other objects of the invention and the various advantages and characteristics of the present combined turbine and centrifugal booster pump 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 an elevational view showing a combined turbine and centrifugal booster pump embodying the invention in connected or operative relation with a power driven main centrifugal pump and a tank for feeding water to the inlet of the casing of the main pump in connection with starting of the latter;

Figure 1a is a plan view of the parts that are shown in Figure 1;

Figure 2 is a fragmentary longitudinal section of the combined turbine and centrifugal booster pump, illustrating in detail the construction, arrangement and design of its component parts; and

Figures 3 and 4 are transverse sections taken, respectively, on the lines 3-3 and 4-4 of Figure 2.

The combined turbine and centrifugal booster pump which is shown in the drawings constitutes the preferred form or embodiment of the invention. It is designed and adapted for use in connection with a main centrifugal pump 5 and a tank 6 for priming the main pump and serves when immersed in a body or source of water at an appreciable distance beneath the main pump 5 and in connection with drive of the latter, to supply water under pressure from the source into the casing of the main centrifugal pump. Although the combined turbine and centrifugal booster pump has many capabilities of use it has special utility as a medium or instrumentality for pumping water from a deep water well including a small sized cylindrical casing 7. As shown in

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Figure 1 of the drawings, the main centrifugal pump 5 is located at the upper end of the casing 7 and the tank 6 for priming the main pump in connection with starting of the latter is located at one side of the main pump. The latter is of standard or conventional design and comprises a volute casing 8 and an impeller (not shown) in the casing. The impeller of the main centrifugal pump is connected for drive by a coaxially disposed shaft (also not shown) which is driven by any suitable source of power, such, for example, as an electric motor or an internal combustion engine. The casing 8 of the pump 5 embodies an inlet 9 in the central portion of the front wall thereof and has a tangential outlet 10 in the portion of its side wall that is of maximum radius. When the main pump 5 is driven the impeller operates to suck liquid into the casing via the inlet 9 and then through the action of its blades to fling the liquid outwards under pressure so that it travels around the side wall of the casing and is finally discharged through the outlet 10, as well understood in the art. The inlet 9 of the main pump casing 8 has associated with it a T fitting 11. One of the longitudinal branches of this fitting is connected to the casing inlet 9 and the other longitudinal branch of the fitting is provided with a control valve 12. The tank 6 is disposed above the main centrifugal pump 5 as well as to one side of the latter and is adapted to contain a column of water. The bottom of the tank 7 is connected to the transverse branch of the T fitting 11 by way of a pipe 13 which has a control valve 14 therein. When the pump 6 is in operation it is contemplated that the valve 14 will be closed. In connection with starting of the main pump the valve 14 is opened. Upon opening of the valve water in the tank 6 flows into the pump casing 8 via the pipe 13 and then in response to the action of the impeller of the main pump is discharged under pressure through the outlet 10 of the casing 8. Said outlet of the casing of the main centrifugal pump 5 has associated with it a T fitting 15. The transverse branch of this fitting is suitably connected to the casing outlet 10 and the longitudinal branches of the fitting are provided respectively with control valves 16 and 17. A hose 18 is connected to, and leads from, the branch of the T fitting 15 that includes the valve 16. The outer end of this hose is provided with a nozzle 19 in order that the water that is pumped by the main pump 5 may be discharged wherever desired. When the main centrifugal pump 5 is in operation while the valve 16 is open water under pressure, as hereinafter described more in detail, is supplied to the hose 18 and is discharged through the medium of the nozzle 19.

The combined turbine and centrifugal booster pump serves, as heretofore pointed out, to boost or pump water in the lower end of the deep well casing to the main centrifugal pump 5 during drive or operation of the latter. It is essentially a self-contained unit and is adapted in connection with use thereof to be disposed in the lower end of the casing 7 where it is fully immersed in the water at the lower end of the well. As its main or principal components the combined turbine and centrifugal booster pump comprises a horizontal casing 20, a horizontally disposed unitary member 21 in the casing and a vertically extending shaft 22 for the rotary member.

The casing 20 is circular in cross section and consists of a cup shaped lower member 23, an inverted cup shaped upper member 24 and a ring shaped member 25 within the lower and upper

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members 23 and 24. The largest external diameter of the casing is less than the internal diameter of the well casing 7 in order that the casing 20 of the combined turbine and centrifugal booster pump may be introduced into, and removed from, the well casing. The cup shaped lower member 23 is preferably in the form of a one-piece casting and consists of a circular bottom wall 26 and a cylindrical side wall 27. The bottom wall 26 embodies in the central portion thereof a circular inlet 28 for the water to be pumped under pressure to the inlet 9 of the casing 8 of the main centrifugal pump 5. The portion of the bottom wall 26 that defines the inlet 28 is provided with an integral downwardly extending annular flange 29. The side wall 27 of the cup shaped lower member 23 of the casing 20 is formed integrally with the outer marginal portion of the bottom wall 26 and embodies at its upper margin an integral inwardly extending annular flange 30. The inverted cup shaped upper member 24 of the casing 20 overlies the lower casing member 23. It is preferably in the form of a one-piece casting and consists of a circular top wall 31 and a downwardly flared circular side wall 32. The central portion of the top wall 31 is provided with a circular outlet 33 for the water that is pumped by the combined turbine and centrifugal booster pump. This outlet 33 is positioned concentrically with respect to, and is of greater diameter than, the circular inlet 28 in the central portion of the bottom wall 26 of the lower member 23 of the casing 20 and is connected to the inlet 9 of the casing of the main centrifugal pump 5 by way of a vertically extending pipe type conduit 34 and a T fitting 35. The conduit 34 is designed to extend through and is of greater length than the well casing 7, as shown in Figure 1. The lower end of the conduit 34 extends into the outlet 33 and is secured in place by a screw thread connection 36. The T fitting 35 is located at the upper end of the conduit 34 and is arranged so that the longitudinal branches thereof extend vertically. The lower longitudinal branch of the T fitting surrounds the upper end of the conduit 34 and is secured to the conduit by a screw thread connection 37. A conduit 38 extends between and serves to connect the transverse branch of the T fitting 35 and the branch of the T fitting 11 that is provided with the control valve 12. When the combined turbine and centrifugal booster pump is in operation water is drawn by suction from the well into the casing 20 via the inlet 28 in the central portion of the bottom wall 26 of the lower casing member 23 and, as hereinafter described more in detail, is forced under pressure upwards into the outlet 33 in the central portion of the top wall 31 of the upper casing member 24. From the outlet 33 the water under pressure flows upwards through the conduit 34 and then flows laterally into the casing of the main centrifugal pump 5 via the conduit 38 and the T fitting 11. The downwardly flared circular side wall 32 of the upper member 24 of the casing is formed integrally with the outer marginal portion of the top wall 31 and embodies at its lower margin an outwardly extending annular flange 39 which, as shown in Figure 2 rests on the inwardly extending flange 30 and is secured to the latter by way of cap screws 40. The ring shaped member 25 is centrally positioned within the casing 20 and is arranged so that the axis thereof extends vertically. It is positioned a small distance beneath the circular outlet 33 and is secured in place by way of an annular series of

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outwardly extending webs 41. The inner ends of the webs are formed integrally with the outer peripheral portion of the ring shaped member 25 and the outer upper corners of the webs are welded or otherwise fixedly secured to the lower marginal portion of the side wall 32 of the upper casing member 24. As shown in Figure 2 of the drawings, the outer lower corners of the webs fit snugly within the upper end of the side wall of the lower casing member 23 and serve to hold said lower casing member in centered relation with the upper casing member. Said outer peripheral portion of the ring shaped member 25 is of less diameter than the outlet 36. The inner peripheral portion of the ring shaped member 25 defines an inlet 42 for the turbine part of the combined turbine and centrifugal booster pump. It is positioned concentrically with respect to the outlet 33 and is connected to the longitudinal branch of the T fitting 15 that includes the control valve 17 by means including a vertically extending pipe type conduit 43. The latter, as shown in Figure 2, extends longitudinally through the pipe type conduit 34 and the longitudinal branches of the T fitting 35. The lower end of the conduit 43 extends into the upper end of the inlet 42 and is secured in place by means of a screw thread connection 44. The upper end of the conduit 43 extends through a packing gland 45 and is connected to the branch of the T fitting 15 having the control valve 17 by way of an elbow 46 and a conduit 47. When the main centrifugal pump 5 is in operation a portion of the water that is pumped through the outlet 10 of the casing 3 flows downwards through the conduit 43 into the circular inlet 42 which, as heretofore pointed out, is defined by the inner peripheral portion of the ring shaped member 25.

The unitary rotary member 21 is located in the lower member 23 of the casing 20 between the ring shaped member 25 and the bottom wall 26 of the casing member 23. It is preferably in the form of a one-piece casting and consists of a circular upper shroud 48, an annular series of arcuate blades 49, a circular intermediate shroud 50, an annular series of arcuate blades 51, a circular lower shroud 52 and a hub 53. The blades 49 extend between, and are connected to, the upper and intermediate shrouds 48 and 50 and define therewith a turbine rotor 54. The central portion of the upper shroud 48 is provided with a circular inlet opening 55 and this is in direct communication with the inlet opening 42 and serves to permit water under pressure to flow into the central portion of the turbine rotor 54 and thence outwards past the blades 49. The blades are so angularly arranged that the water under pressure in passing thereby causes rotation of the unitary rotary member 21. The portion of the upper shroud 48 that defines the inlet opening 55 embodies an integral upwardly extending cylindrical sealing ring 56 which is mounted rotatably in the lower end of the inlet 42 that is defined by the inner peripheral portion of the ring shaped member 25. The blades 51 extend between, and are connected to, the intermediate and lower shrouds 50 and 52 and together with the latter define a closed variety pump impeller 57. The central portion of the lower shroud 52 is provided with an inlet opening 58 and this, as shown in Figure 2, is in direct communication with the inlet 28 in the bottom wall 26 of the lower casing member 23 and serves to admit water into the central portion of the impeller 57. The portion of the lower shroud that

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defines the inlet opening 58 embodies an integral depending or downwardly extending cylindrical sealing ring 59 and this fits rotatably in the inlet 28. When the unitary rotary member 21 is driven in response to outward flow of water under pressure past the blades 49 of the turbine rotor 54 water is drawn by suction into the center of the pump impeller 57 and is flung outwards by the blades 51 against the inner periphery of the side wall 27 of the lower casing member 23. The water that is forceably projected outwards by the pump impeller unites with the water that passes through the turbine rotor and then flows upwards under pressure through the outlet 36 and the conduit 34. After flowing through the conduit the water under pressure flows into the inlet 9 of the casing 8 of the main centrifugal pump 5, as hereinbefore pointed out. As shown in Figure 2 the diameter of the unitary rotary member 21 forming the turbine rotor 54 and the closed variety pump impeller 57 is less than the internal diameter of the side wall 27 of the lower casing member 23. By reason of the fact that the turbine rotor 54 and the pump impeller 57 are formed integrally with one another the construction and design of the combined turbine and centrifugal booster pump are materially simplified. In view of the fact that the water that is discharged from the turbine rotor 54 mixes with the water that is pumped by the pump impeller 57 the casing of the combined turbine and centrifugal booster pump requires but a single outlet and it is possible to make the casing 20 extremely small and thus adapt the combined turbine and centrifugal booster pump as a whole for use in a small space, such, for example, as the bottom of a deep well casing. The hub 53 of the unitary rotary member 21 is formed integrally with, and projects upwards from, the central portion of the intermediate shroud 50. The central portion of the hub 53 is upwardly tapered and serves to guide or direct outwards towards the blades 49 the water under pressure that is introduced into the central portion of the turbine rotor 54 via the inlet 42.

The vertically extending shaft 22 is positioned so that the central portion thereof extends centrally through the inlet 28 in the bottom wall 26 of the lower casing member 23. The upper end portion of the shaft fits within, and is keyed or otherwise fixedly secured to, the hub 53 of the unitary rotary member 21. The central and lower end portions of the shaft 22 are journaled in a vertically extending cylindrical bearing 60. As shown in Figure 2 this bearing is disposed in coaxial relation with, and is of materially less diameter than, the inlet 28. The lower end of the bearing 60 is carried by, and fits snugly within, a cup shaped element 61. Such element is disposed beneath the casing 20 and embodies at its upper end a plurality of upwardly and outwardly extending arms 62, the upper ends of which are connected to the annular depending flange 25 on the bottom wall 26 of the lower casing member 23. A thrust bearing in the form of a ball 63 is located in the lower end of the cylindrical bearing 60 and serves to prevent downward displacement of the shaft and unitary rotary member relatively to the casing 20. The upper end of the bearing 60 terminates slightly beneath the hub 53 and is upwardly flared so as to direct outwards towards the blades 51 the water that is drawn or sucked into the inlet 28 during drive or rotation of the unitary rotary member 21.

In addition to the parts heretofore mentioned the combined turbine and centrifugal booster pump comprises a check valve 64 for preventing back flow of water through the inlet 28 when drive or rotation of the unitary rotary member 21 ceases. This valve is disposed beneath the cup shaped element 61 and is associated with a cup shaped housing 65. The latter consists of a circular bottom wall 66 and an upstanding cylindrical side wall 67. The upper end of the side wall extends around the depending annular flange 29 on the bottom wall 26 of the lower casing member 23 and is removably secured in place by a screw thread connection 68. The bottom wall 66 of the housing 65 embodies a central circular hole 69, the upper portion of which is downwardly tapered in order to form an annular valve seat 70. The check valve 64 is disposed within the lower portion of the housing 65 and is adapted to slide vertically into and out of a closed position wherein it is in seated relation with the seat 70. A stem 71 in the form of a pair of crossed webs is connected to and depends from the check valve 64 and extends slidably through the circular hole 69 in the bottom wall of the cup shaped housing 65. When the unitary rotary member 21 is not in operation and resultantly there is no suction in the inlet 28 the check valve 64 assumes its closed position in response to the action of gravity. As soon as the member 21 is set in motion the check valve 64 slides upwards due to suction being created above it and the fact that the water under it exerts upward pressure on it. Upon opening of the check valve water flows into the housing 65 and thence upwards through the inlet 28 into the center of the pump impeller 57.

When it is desired to use the combined turbine and centrifugal booster pump it is immersed in the source of water to be pumped. If the source is a deep well, for example, the combined turbine and centrifugal booster pump is lowered into the lower end of the well casing. As soon as the unit is immersed in the water source the valve 14 is opened and the main centrifugal pump 5 is then set in operation. Opening of the valve 14 results in water flowing from the tank 6 into the inlet of the casing 8 of the main pump and also into the pipe type conduit 34. As soon as the main centrifugal pump starts to operate a portion of the pumped water flows downward through the pipe type conduit 43 into the center of the turbine rotor 54. Passage of water under pressure into the turbine rotor results in drive of the unitary rotary member 21. In connection with drive of the member 21 water is drawn into the center of the pump impeller 27 via the housing 65 and the inlet 28 and is forced outwards under pressure through the outlet 33 and thence upwards through the conduit 34 into the inlet of the casing of the main centrifugal pump. In the event of stoppage of the main pump the check valve 64 moves by gravity into its closed position wherein it seals the opening or circular hole 69 and thus locks the water in the casing 20 and the conduits 34 and 43. In connection with operation of the combined turbine and centrifugal booster pump the water which is used for purposes of effecting rotation of the unitary rotary member 21 mixes with the water that is pumped by the impeller 57 and flows upwards with the latter into the inlet of the casing of the main centrifugal pump 5.

The herein described combined turbine and centrifugal booster pump, due to the design, construction and arrangements of the parts thereof, is of exceptionally small size and in ad-

dition is extremely highly efficient so far as operation is concerned. It is essentially a self-contained unit, has extremely long life, and is capable of being produced or manufactured at a low and reasonable cost.

The invention is not to be understood as 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. A combined turbine and centrifugal booster pump comprising a casing consisting of cup-shaped lower member having a small sized, centrally disposed, circular liquid inlet in the bottom wall and an integral annular depending flange around said inlet, a complemental inverted cup-shaped upper member mounted on, and secured to, the lower member and having a large sized, centrally disposed, circular outlet opening in its top wall, and a vertically elongated ring shaped member disposed concentrically within the central lower portion of the upper member and the central upper portion of the lower member, having the inner periphery thereof defining a second liquid inlet and its outer periphery defining with the adjacent portions of the inner peripheries of the side walls of the upper and lower members a liquid outlet duct leading from the outer portions of the interior of the lower member to said outlet opening and provided with integral vertically elongated outwardly and radially extending webs the upper outer corners of which are fixedly connected to the lower end of the side wall of the upper member and the lower outer corners of which fit snugly within the upper end of the side wall of the lower member and serve to hold said lower member in centered relation with the upper member of the casing; and a horizontally extending one-piece member mounted rotatably in the lower portion of the lower member of the casing and embodying a flat circular upper shroud directly beneath the lower end of the ring shaped member and the upper extremity of the side wall of the lower member of the casing, a flat circular lower shroud directly above the bottom wall of said lower member, a flat circular intermediate shroud in spaced relation between the upper and lower shrouds, an annular series of blades between the upper shroud and the intermediate shroud, and an annular series of blades between the lower shroud and said intermediate shroud, the upper shroud having a central opening therein in registry and communicating relation with the lower end of the liquid inlet in the ring shaped member and in addition an integral upwardly extending cylindrical sealing ring extending around the last mentioned opening and fitting rotatably in the lower end of the ring shaped member, and forming with the intermediate shroud and the first mentioned annular series of blades an outflow variety turbine rotor adapted in response to flow of liquid under pressure through said inlet in the ring shaped member to effect drive of the member and at the same time direct the liquid outwards against the side wall of the lower member of the casing for discharge via the outlet duct, the lower shroud having in the central portion thereof a central opening in registry and communicating relation with the liquid inlet in the bottom wall of the lower member of the casing, also having an inte-

gral depending cylindrical sealing ring extending around the last mentioned opening and fitting rotatably within said annular depending flange, and defining with the intermediate shroud and the second mentioned annular series of blades a closed variety pump impeller adapted in response to drive of the member to draw liquid through the last mentioned liquid inlet and to force the liquid under pressure outwards against the side wall of the lower member for discharge via said outlet duct.

2. A combined turbine and centrifugal booster pump comprising a casing consisting of a cup-shaped lower member having a small sized, centrally disposed, circular liquid inlet in its bottom wall and an integral annular depending flange around said inlet, and a complemental inverted cup-shaped upper member mounted on, and secured to, the lower member and embodying means forming a small sized, vertically elongated, centrally disposed second liquid inlet and a large sized, vertically elongated, annular liquid outlet duct extending around said second inlet and leading upwards from the outer portion of the interior of the lower member; a horizontally extending outflow variety turbine rotor mounted in the casing directly beneath the lower end of said second inlet and adapted in response to downflow of the liquid under pressure through said second inlet to revolve and at the same time direct the liquid outwards against the side wall of the lower member of the casing for discharge via the annular outlet duct; a horizontally extending impeller mounted in the casing directly above the bottom wall of the lower member, connected to, and for drive by, the turbine rotor, embodying a lower shroud with a central opening therein in registry and communicating relation with the inlet in the bottom wall of the lower member and also with an integral depending cylindrical sealing ring extending around the opening and fitting rotatably within the depending flange, and adapted in response to drive to draw liquid through the liquid inlet in said bottom wall of the lower member and force the liquid under pressure outwards against the side

wall of the lower member for discharge via said annular outlet duct; means for rotatably supporting the rotor and impeller, embodying a cup-shaped element of less diameter than the depending flange, disposed directly beneath but in spaced relation with said flange and connected to the latter by an annular series of integral upwardly extending spaced apart arms, and a vertically extending shaft having the lower end thereof journaled in the cup-shaped element and its upper end connected to the central portions of said rotor and impeller; a cup-shaped housing surrounding and spaced from the cup-shaped element, having the upper end of the side wall thereof extending around and connected by a screw thread to the aforementioned depending flange having in its bottom wall a centrally disposed circular hole with an annular valve seat around its upper portion, and having its interior in communication with its liquid inlet in the bottom wall of the lower member by way of the spaces between said arms; and a check valve disposed in the lower portion of the cup-shaped housing and mounted so that it is slidable vertically back and forth between an open position wherein it is in abutment with the bottom of the cup-shaped element and a closed position wherein it seats against said annular seat.

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