

June 17, 1947.

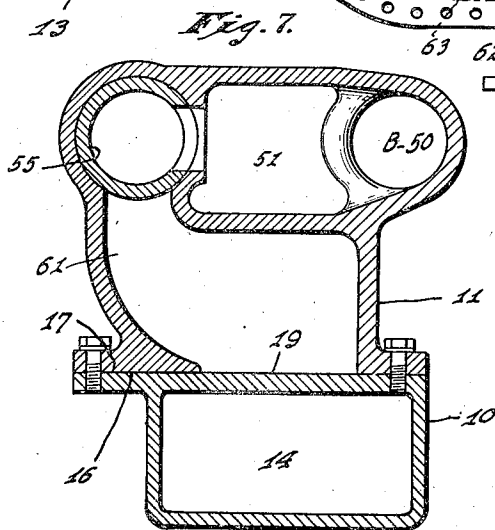
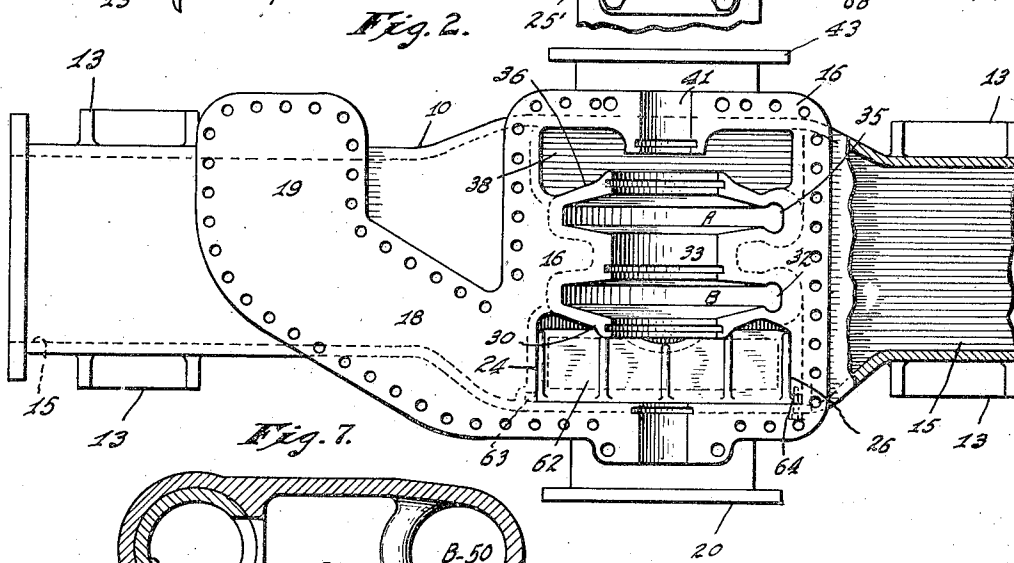
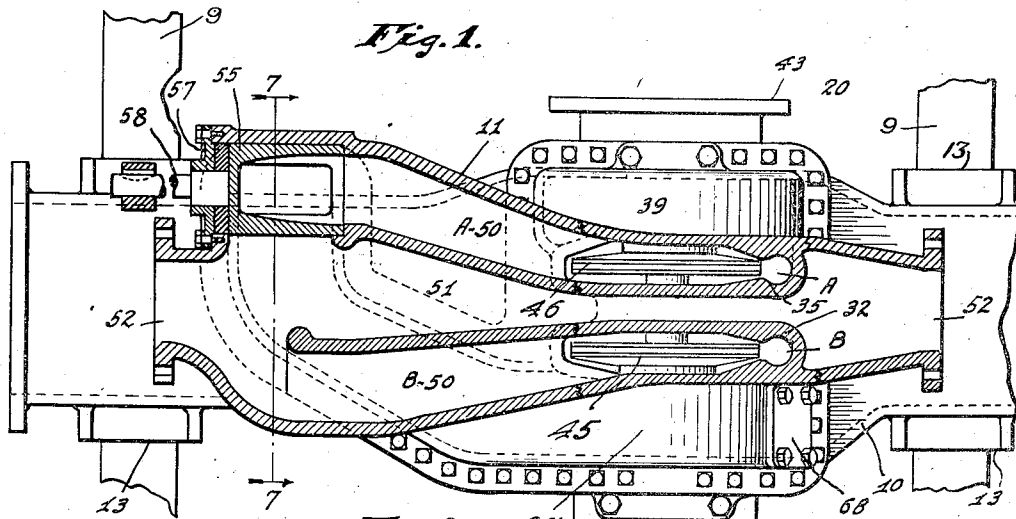
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2,422,415

CENTRIFUGAL PUMP

Filed Dec. 13, 1943

3 Sheets-Sheet 1



BY

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3 Sheets-Sheet 2

Fig. 3.

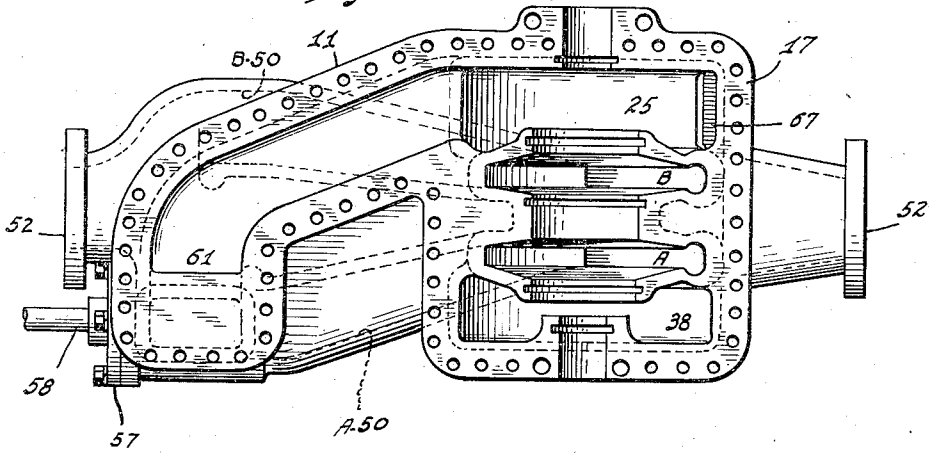
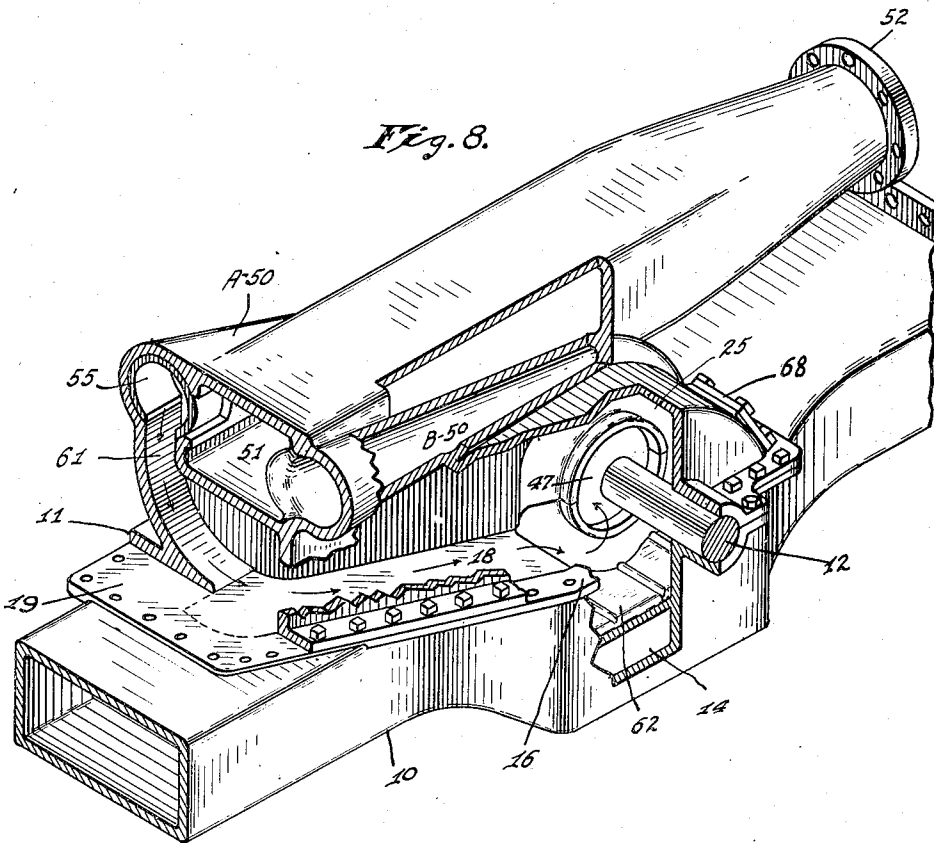


Fig. 8.



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CENTRIFUGAL PUMP

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1

This invention relates to a centrifugal pump, and especially to a two-stage centrifugal pump in which the two stages may be operated either in series or in parallel and which is especially adapted to be mounted on a truck for fire fighting purposes.

The conditions of use for such a pump and its suitability for integration with other necessary equipment on a fire truck impose severe requirements. The pump must be reliable and efficient. To this end, it must be simple to operate and to maintain, and hence must be composed of relatively simple parts arranged in an accessible manner; and its water passages must be either straight or smoothly curved, and must be arranged to avoid air lock. It must be well adapted for mounting on the truck, and hence must be compact and arranged to use economically the space it occupies; and it must be relatively light in weight. It should have inlet and outlet openings on both sides of the truck, so that it may be connected from either side, and must operate efficiently when connected from either or both sides. It must operate efficiently either when its stages are in parallel or when they are in series, and must be easily converted from one condition of operation to the other.

It is the object of this invention to provide an improved series-parallel centrifugal pump which will meet these requirements. The pump embodying this invention is desirably composed of two main castings, fitting together in a horizontal plane. The lower casting is adapted to be mounted transversely on the frame of a truck, and forms an intake manifold with intake openings at both ends. Two centrifugal pump units are formed in the castings, on a common axis in the plane of separation of the two castings, with that common axis spaced from the center of the lower casting (to the right in the drawings) toward one end of the pump assembly, so that it will lie near one side of the truck. The volutes for the two pumps discharge at the top of the pump units, and long, substantially straight diffusers lead from them with a slight upward inclination toward the opposite end of the pump assembly. A double-ended outlet manifold, extending parallel with the intake manifold lies between the discharge ends of the diffusers.

One of the diffusers is in open communication with the outlet manifold. The other diffuser leads into the open end of a cup-shaped valve, which may be turned to discharge through its side outlet either laterally into the outlet passage—for parallel operation of the pump units—

2

or downwardly into a return passage. That return passage leads downwardly from that cup-shaped valve and transversely beneath the outlet manifold and the first diffuser and diagonally back to the suction chamber of the pump unit supplying the first diffuser and is formed so that the top wall of the lower casting is its floor. That suction chamber, half in the upper casting and half in the lower casting, has an upwardly opening check valve in its floor, which closes the suction chamber to the intake passage when water enters it at higher pressure from the return passage—during series operation.

The accompanying drawings illustrate our invention. In such drawings, Fig. 1 is a top plan with parts broken away to show the diffusers and the outlet manifold in section; Fig. 2 is a top plan of the lower casting; Fig. 3 is a bottom plan of the top casting; Fig. 4 is a side elevation, with parts broken away to show the intake passage, the return passage, and the suction chamber in section; Fig. 5 is a vertical section through the axis of the pump units, on line 5-5 of Fig. 4; Fig. 6 is a vertical partial-section on the line 6-6 of Fig. 5, showing details of the check valve; Fig. 7 is a vertical section on the line 7-7 of Fig. 1; Fig. 8 is an isometric view with the valve-end of the upper casting cut away in the plane of Fig. 7, and with other parts broken away and shown in section to illustrate series operation of the pump; and Fig. 9 is a vertical partial-section on the line 6-6 of Fig. 5 showing a modified form of the floor of the return passage at its outlet end.

The pump shown in the drawings is made of two main castings—a lower casting 10 and an upper casting 11—arranged with horizontal mating faces in a plane containing the axis of the main shaft 12 of the pump. The lower casting, best seen in Figs. 2 and 4, is adapted to be mounted directly on the longitudinal frame members 9 of a truck and to be secured thereon by mounting pads 13. The lower casting forms an undivided intake manifold 14 extending throughout its length and having an intake port 15 at each end, desirably provided with a mounting flange to receive a fitting (not shown) to which intake hose may be attached. The intake ports 15, only one of which is shown, are symmetrical and equally spaced from the respective mounting pads 13.

The axis of the shaft 12 is spaced from the mid point of the lower casting 10 toward one end of the pump assembly—to the right in Fig. 4. The portion of that casting 10 adjacent to

the shaft 12 is widened and deepened, and is provided with a plane top surface 16 to receive the mating lower surface 17 of the top casting 11. As is seen in Figs. 2 and 3, those mating surfaces have a generally rectangular portion, and a narrower diagonal portion 18 leading to a transverse portion 19 near the opposite end of the pump assembly.

At the widened portion of the lower casting, the two castings 10 and 11 are shaped to form the two pump units A and B. The main shaft 12 of two pump units is received with the axis of the shaft lying in the plane of the mating surfaces 16—17 along the transverse center line of the rectangular portion of those mating surfaces. Reading along the axis of that shaft 12, from the bottom to the top of Fig. 2, from top to bottom in Fig. 3, and from left to right in Fig. 5, the parts formed in the castings are as follows:

First, there is a mounting plate 20 for mounting either the outboard bearing 21 or the driving transmission 22 which embodies outboard bearings for its end of the shaft 12. Next, there is an outer side-wall formed to receive a packing gland 23 for the shaft 12, then a suction chamber 25 for pump unit B.

The top and one end of the upper half of this suction chamber 25 is formed of a curved wall 25' in the upper casting which extends upwardly from a flange forming part of the mating surface 17. In the lower casting 10, the suction chamber 25 is defined at its ends by walls 24 and 26 and at its bottom by a check valve seat 27.

The wall at the inner side of the suction chamber 25 forms one wall of the impeller housing of pump unit B, and provides a seat 30 to receive a wear-ring 31 to surround the eye of the impeller of the pump unit B.

An inner impeller-housing wall lies beyond said first wall, and a volute 32 is formed at their outer edges. Beyond the impeller-housing of pump unit B, the castings carry a bearing-spacer 34; then form the impeller-housing and volute 35 for pump unit A; then a seat 36 for a wear ring 37, to surround the eye of the impeller of pump unit A; and then a suction chamber 38 for pump unit A.

The upper half of the suction chamber 38 is defined by a semi-cylindrical top wall 39 formed on the upper casting 11. Its lower half, however, is fully open to the intake passage 14, and the horizontal, planar, top wall 16 of the intake passage 14 extends without obstruction on its lower surface to an opening in it which defines the suction chamber 38. This freedom from obstruction and pockets on or in the top wall of the intake passage 14 permits any air in the intake manifold 14 to escape freely into the suction chamber 38, from which it will be discharged. Because the intake manifold 14 is undivided, air will also be discharged by this path from adjacent to the depending lower walls of the suction chamber 35 of pump unit B. Pumps of this type are usually carried on a fire truck in dry condition and are primed immediately prior to use, hence this effective provision for elimination of air is important, to prevent the occurrence of air lock to interfere with the operation of the pump.

Beyond the suction chamber 38 for pump unit A, the outer wall is formed to receive a packing gland 42 to seal around the main shaft 12. This outer wall carries a mounting plate 43 similar to mounting plate 20, to receive either the driving transmission 22 or the outboard bearing 21. The use of opposite mounting plates 20 and 43 similar

to each other, permits the driving transmission to be readily mounted at whichever position is most convenient.

The main shaft 12 is mounted in the outboard bearing 21, and in bearings in the transmission 22, and is supported at its mid portion by the bearing spacer 34. It carries the two impellers 45 and 46 for the two pump units B and A respectively. Each of such impellers has an inlet eye 47 which has a running fit with its associated wear-ring 31 or 37, and has suitably designed impeller passages extending toward its periphery to discharge into its associated volute.

The volutes of the two pump units are of gradually increasing cross-sectional area, beginning at the top, substantially at the plane of line 5—5 in Fig. 4, and proceeding counterclockwise around the pump units to discharge points which also lie substantially at the plane of line 5—5 in Fig. 4. At such discharge points, the volutes merge smoothly into diffusers A50 and B50 for the respective pump units A and B, which continue a gradual increase in cross-sectional area. The axes of the diffusers are substantially straight, but have a slight divergence between them and a slight rise as they lead to the right in Figs. 1, 4, and 8 toward the opposite end of the pump assembly. By reason of the displacement of the pump-axis toward one end of the pump assembly, and leading the diffusers toward the opposite end, the diffusers may be both substantially straight and relatively long. In the pump shown, they have a length of the order of one and one-half times the diameter of the pump impellers 45 and 46.

An outlet manifold passage 51 lies between the discharge ends of the two diffusers and extends in both directions to outlet ports 52 presented respectively to opposite ends of the pump assembly. Each outlet port 52 is provided with means such as a suitable flange to receive discharge fittings (not shown) which may have any desired number or arrangement of fire hose connections. The outlet passage 51 is of substantially uniform cross-sectional area throughout its length, and for this purpose as well as to decrease weight, its lower wall dips between the two pump units to below the level of the volutes 32 and 35. To facilitate mounting the pump in a truck, and maintenance of it without removal therefrom, the outlet manifold 51 is relatively shorter than the intake manifold 14.

The discharge end of diffuser B—50 is in open communication with the outlet passage 51. The diffuser A—50 leads into the open end of a cup-shaped valve 55, substantially co-axial with the terminal portion of the diffuser. The valve 55 forms a smoothly curved passage leading to an outlet through its side, and has one position in which that side opening communicates with a port into the outlet manifold 51, in which position of the valve 55 two pump units A and B operate in parallel.

The cup-shaped valve 55 is mounted in a cylindrical recess co-axial with the discharge end of the diffuser A—50 and with its axis generally parallel to the axes of the manifolds 14 and 51. The valve-receiving recess is formed in the end of the upper casting 11 where it may easily be machined. The valve 55 is held in that recess by a plate 57, through which the axial valve stem 58 for the valve 55 extends. This position of the valve stem 58, parallel with the axes of manifolds 14 and 51, permits it to be connected directly to a suitable handle 59 in a conveniently accessible position adjacent one outlet of the pump

5

and outside the outer wall 60 of the truck on which the pump is mounted.

The valve 55 has a second position, shown in Fig. 8, in which its side opening is directed downward. From this position of the valve opening, a return passage 61 leads downward through a smooth curve and horizontally beneath the discharge manifold 51 and diffuser B—50 and diagonally back toward and to the suction chamber 25 for pump unit B. The top and side walls of this return passage 61 are formed in the upper casting 11; but its lower wall is formed by the top surface 16 of the lower casting.

With the valve 55 in its second position, to discharge into the return passage 61, the discharge from pump unit A through diffuser A—50 is led through that return passage 61 to the suction chamber 25 of pump unit B. A check valve 62, on the seat 27 (see Figs. 2, 4, 5, and 6) in the floor of the suction chamber 25, then closes that suction chamber 25 against communication with the intake manifold 14; and pump unit B is supplied wholly by water from pump unit A. The two pump units then operate in series.

The check valve 62 is generally rectangular, but has the mid-portion of its free side edge cut out, to clear the main shaft 12 when the valve is in open position and to clear the lower portion of the seat 30 of the wear-ring 31 when the valve approaches closed position; and the valve seat 27 is suitably shaped to conform with this cut-out configuration.

Pivot pins 63 and 64 are formed at the ends of the opposite side of the check valve 62. In one modification (Figs. 4 and 6), the pivot 63 is received in a socket formed in the end-wall 24 of the suction chamber 25; and pivot 64 is received in the bottom of a vertical slot 65 formed in the end-wall 26 of the suction chamber 25. A bolt 66 passing through the outer side wall of intake manifold 14 and across the slot 65 serves to keep the pivot 64 in place. By removal of the bolt 66, the valve 62 may be lifted from its seat and removed. In another modification (Fig. 9), each pivot pin 63 and 64 is received in a slot 65 and held in place by a bolt 66 inserted from outside through the side wall of the lower casting 10. An access opening 67, normally closed by a plate 68, is formed in the upper curved wall 25' of suction chamber 25 to permit access to the check-valve 62 in the event that it becomes fouled by foreign matter.

The valve 62, in cross section, is formed with a slight taper from its pivot edge to its free edge, and its top surface (when closed) is provided with a series of spaced ribs 69 extending from the pivot side of the valve toward the free edge thereof. When the valve 62 is in open position, these ribs lie against the outer side wall of the intake passage 14, and provide between them spaces which are open at the free edge of the valve.

When the pump is changed from parallel to series operation, and the discharge from pump unit A is led through return passage 61 to the suction chamber 25 of pump unit B, flow of water through the port formed by the seat 27 of the check valve 61 is reversed; and by the closing of the valve 61, is stopped. During any such reverse, or downward flow through such port, the spaces between the ribs 69 and behind the valve 62 are open against the direction of that reverse flow; and the water enters those spaces to exert a positive force tending to move the valve 62 from its open position.

In the modification of Fig. 6, where the end

6

wall 24 of the lower part of the suction chamber 25 is vertical, and reverse flow of water would be generally downward at the free edge of the valve 62 in open position, the ribs 69 are normal to that top edge. In the modification of Fig. 9, however, where the wall 24' of the suction chamber 25 is a downwardly inclined continuation of the floor 16 of the return passage 61, and the reverse flow of water would be diagonal at the free edge and one end of the valve 61, the ribs 69' are desirably disposed diagonally, to present the spaces between the ribs 69' more directly against that direction of flow.

Parallel operation of the pump is as follows:

The manual valve 55 is turned to the position shown in Fig. 7, in which water passing through it will be discharged into the outlet passage 51, and the return passage 61 will be cut off from communication with the diffuser A—50. In this condition, each of the two pump units A and B will receive water from the intake passage 14, by way of the suction chambers 25 and 38, that water will be discharged from the volutes 32 and 35 from the pumps into the two diffusers 50. In those diffuser passages, the velocity of the water will be reduced, and its kinetic energy will be substantially changed to pressure energy. From both diffuser passages 50, the water will flow into the outlet passage 51 and will be discharged through whichever one of the outlet ports 52 is open, as to communicate with one or more fire hose.

Parallel operation of the pump will deliver a relatively large quantity of water, at the pressure given to it by the action of a single-stage pump unit—a lower pressure than when the two pump units act in series.

Series operation of the pump, best shown in Fig. 8, is as follows: The manual valve 55 is turned to its downwardly open position as shown in Fig. 8, to discharge into the return passage 61 and to cut off communication between diffuser A—50 and the outlet manifold 51. In this condition, water will flow from intake passage 14 through the suction chamber 38 to the pump unit A, and will be discharged through its volute 35 to the diffuser A—50. In that diffuser A—50 the velocity of the water will be reduced, and the kinetic energy imparted to it by pump unit A will be largely changed to pressure energy. The water will then have the pressure imparted by a single pump-stage. Then, as shown by the arrows in Fig. 8, it will flow through the downwardly open port of manual valve 55 into the transfer passage 61, and will be led back to the suction chamber 25 of pump unit B. The water reaching suction chamber 25 from the return passage 61, being at a higher pressure than the water in the intake passage 14, will tend to flow past check valve 62 into that intake passage 14. As has been pointed out, any such flow will force water behind the check-valve 62; to close it. Once closed, the pressure differential will hold it in closed position.

With valve 62 closed, the water discharged from diffuser A—50 and led to pressure chamber 25 by the return passage 61 will enter pump unit B, will be acted upon thereby, and will be discharged from that pump with added energy into volute 32, and thence into diffuser B—50. In the diffuser B—50, the kinetic energy added to the water by pump unit B will be largely changed to pressure energy, and the water will then be discharged from diffuser B—50 into the outlet manifold 51.

7

In this series operation of the pump the quantity of water delivered would be relatively smaller than that delivered by parallel operation of the pump, but that smaller quantity of water will be delivered at a high pressure.

This invention provides a pump of simple and compact construction. It requires but two main castings, which have but few machined surfaces. These are simple surfaces, positioned for easy machining. The castings mate on a single planar surface, which facilitates preparation and assembly. The surface of the lower casting is made to serve as the floor of substantially the only passage which would otherwise be difficult to core in the casting procedure, and thus further facilitates manufacture. If necessary, the pump may be disassembled readily and without removal from its mounting on a truck.

The pump may be connected from either or both sides of a truck on which it is mounted. It may be connected to draw water either from a hydrant or from some natural source such as a river. Its two pump units may be operated either in series or in parallel, and change from one to the other is accomplished by manual operation of but a single handle, conveniently located. The valve so operated is placed for easy connection to its handle and its simple construction facilitates its assembly and minimizes maintenance requirements. The single check valve of the pump is reliable in operation and is easily accessible without dismantling the pump in the event of its being fouled by foreign matter in the water.

The water passages of the pump, while compactly arranged, are straight or smoothly curved, particularly those passing water at high velocity. Long, substantially straight diffusers merge smoothly from the pump volutes, to give good transformation from the kinetic energy imparted to the water by the impellers to pressure energy delivered at the outlet manifold. The construction makes for ease of manufacture, adaptable mounting, simplicity of operation, and efficient pumping.

We claim as our invention:

1. In a series-parallel centrifugal pump adapted to be mounted transversely on the longitudinal frame members of a truck and comprising an upper and a lower housing mating in a horizontal plane, the lower housing forming an intake manifold with opposite end-inlet ports, and an outlet manifold in said upper housing with opposite end-outlet ports presented parallel with said intake ports, the combination of a pair of pump units formed in said housings, a main shaft for said pump units on a transverse axis in said mating plane, impellers in said pump units and mounted on said main shaft, said axis and pump units being offset toward one end of said intake manifold, volutes for said two pump units terminating adjacent to a vertical plane containing the axis of the pump shaft, diffusers of gradually increasing cross-sectional area merging from said volutes substantially tangentially and leading toward the opposite end of the outlet manifold, one of said diffusers being in open communication with said outlet manifold, a valve recess at the end of said other diffuser, an outlet port from said recess to said outlet manifold, a suction chamber for the pump unit supplying said open diffuser, a return passage leading from said valve recess downwardly and transversely between the outlet and intake-manifolds and back to said suction chamber, an intake port in the floor of said

8

suction chamber for inflow from said intake manifold, a check valve to prevent reverse flow through said intake port, and a manually operable valve in said valve recess to receive the discharge from said other diffuser, said valve having a position in which it discharges into said outlet-port and a second position in which it discharges into said return passage.

2. The combination set forth in claim 1, in which said valve is a cup-shaped valve co-axial with the discharge end of its associated diffuser and is arranged to receive water through its open end and to discharge such water through a side opening, the axis of said valve being substantially parallel with the axes of said intake- and outlet-manifolds.

3. In a series-parallel centrifugal pump, a rotor, a spaced pair of impellers mounted on said rotor, volutes for said impellers, an intake passage below the common axis of said impellers, said two volutes being arranged with their discharge ends at the top, a diffuser of gradually increasing cross-sectional area leading tangentially from the discharge end of each said volute, the axes of said diffusers being substantially straight and co-planar, an outlet passage extending in the same direction as said diffusers and passing between them, the end of one of said diffusers being in open communication with said outlet passage, a return passage leading from the discharge end of the other of said diffusers downwardly and transversely beneath said outlet passage and said one diffuser above the level of the axis of said impellers to open communication with the inlet side of the rotor supplying said one diffuser, a check valve between said impeller inlet and said intake passage, and valve means at the end of said other diffuser to direct the outflow therefrom either to said outlet passage or to said return passage.

4. In a series-parallel centrifugal pump, a pair of co-axial pump units formed in a pair of main castings separable on a horizontal plane containing the axes of said pump units, diffusers leading from the tops of said units generally in the same direction and substantially horizontally, valve means at the end of one of said diffusers to direct the discharge thereof into confluence with the discharge from said other diffuser, and a return passage leading downwardly from said valve means, curving to horizontal and rearwardly below said other diffuser and above the level of said pump axis, a suction chamber at the inlet of pump unit associated with the other of said diffusers, said return passage being connected to said suction chamber and having its top and side walls formed in the top main casting and its bottom wall on the bottom main casting.

5. In a series-parallel centrifugal pump, a pair of co-axial pump units, diffusers leading from the tops of said units generally in the same direction and substantially horizontally, valve means at the end of one of said diffusers to direct the discharge thereof into confluence with the discharge from said other diffuser, and a return passage leading downwardly from said valve means, curving to horizontal and rearwardly below said other diffuser and above the level of said pump axis, a suction chamber at the inlet of the pump unit associated with the other of said diffusers, said return passage being connected to said suction chamber, a check valve in said suction chamber pivoted on a generally horizontal axis below the inlet to said suction chamber from said return

passage, said valve having an upright open position against a side-wall of said suction chamber, channels in the back face of said valve open at a free edge thereof and positioned to form with said wall pockets which are open against the direction of flow from said return passage to the port for said check-valve.

6. In a series-parallel centrifugal pump, a housing forming an intake manifold, a pair of pump units with their lower halves formed in said housing, the impellers of said two pump units being mounted on a common shaft the axis of which lies in the upper wall of said housing, a suction chamber for one of said pump units, the lower portion of said suction chamber being formed between the casing of its associated pump unit and the outer wall of said manifold housing and by transverse walls depending from the upper wall of said manifold housing, a valve seat formed at the lower ends of said depending walls, a check valve pivotally mounted adjacent the outer housing wall and operable to prevent flow from said suction chamber to said manifold, a discharge passage to which the pump unit associated with said valved suction chamber is connected, means including a valve for directing the discharge from said other pump unit either to said discharge passage or to said valved suction chamber above the valve therein.

7. In a series-parallel centrifugal pump as defined in claim 6, said check valve pivotal mounting comprising a pivot pin and socket at one end, a pivot pin carried by the other end of said check valve, a vertical slot in the depending wall at said other check-valve end to receive said pivot pin at its bottom and permit said pivot pin to be lifted, and a bolt insertable from outside said pump to lie across said vertical slot to hold said pivot pin in pivoting position.

8. In a centrifugal pump, an intake manifold having a horizontal top wall, a pair of pump units formed with their axes lying transversely across said top wall, a suction chamber for one of said pump units with its lower half defined by walls depending from said top wall and communicating with said manifold therebelow, a suction chamber for the other pump unit in open communication with said intake manifold at said top wall, said manifold being formed to permit free flow from adjacent said depending walls to said open communication.

9. In a series-parallel centrifugal pump, a discharge passage, a pump unit on an axis transverse to said discharge passage and spaced rear-

wardly from an outlet of said discharge passage, a substantially straight diffuser extending from said pump unit to a terminal portion generally parallel with said discharge passage at its said outlet end, a cylindrical valve casing co-axial with said terminal portion at the discharge end thereof, a cup-shaped valve in said valve casing having an open end positioned to receive the discharge from said terminal portion, a side discharge opening in said valve, a valve operating member extending axially from said valve in the same general direction as said discharge passage outlet, a second pump unit, passages leading from said valve casing respectively to the inlet of said second pump unit and to said discharge passage, said valve having positions to discharge respectively into said passages from said valve casing, and a valve associated with the inlet of said second pump unit to close its normal supply passage when said first pump unit discharges to said second pump unit.

10. In a series-parallel centrifugal pump, a pump unit, a generally straight diffuser passage leading from said pump unit, a cylindrical valve casing at the end of said diffuser substantially co-axial with a terminal portion of said diffuser, a cup-shaped valve in said casing having an end inlet opening forming a substantial continuation of said diffuser, a side discharge opening in said cylindrical valve casing, a second pump unit, a discharge passage connected to receive discharge from said second pump unit, means connecting said ports respectively with said discharge passage and with the inlet of said second pump unit, and a valve associated with the inlet of said second pump unit to close its normal supply passage when said first pump unit discharges to said second pump unit.

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