June 23, 1936. E. J. WENDELL 2,045,505

CENTRIFUGAL PUMP

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Fig. 1.

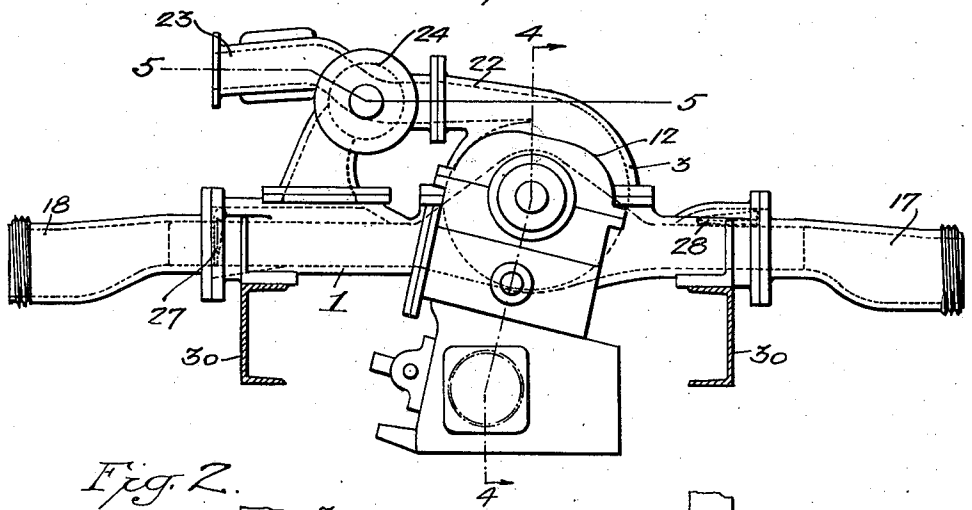


Fig. 2.

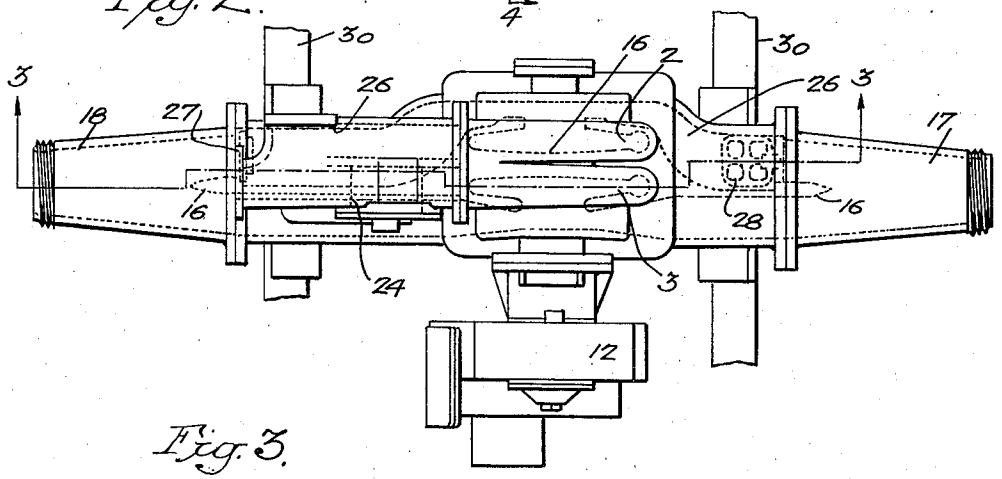
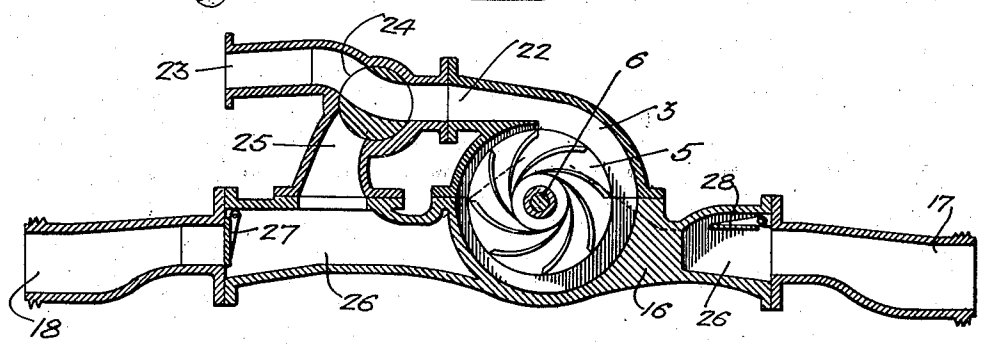


Fig. 3.



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Fig. 6.

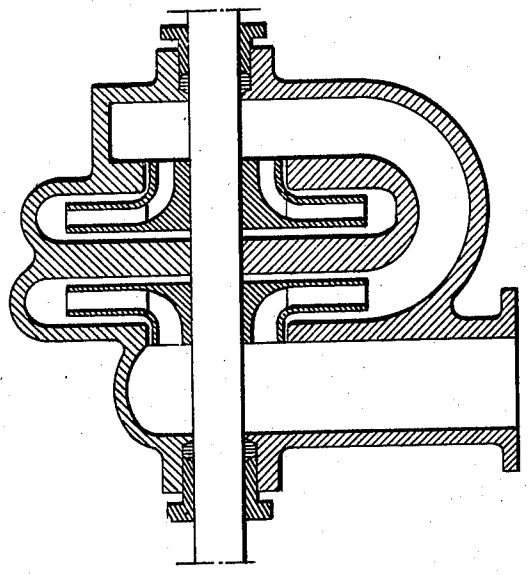


Fig. 5.

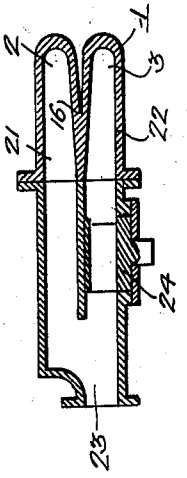
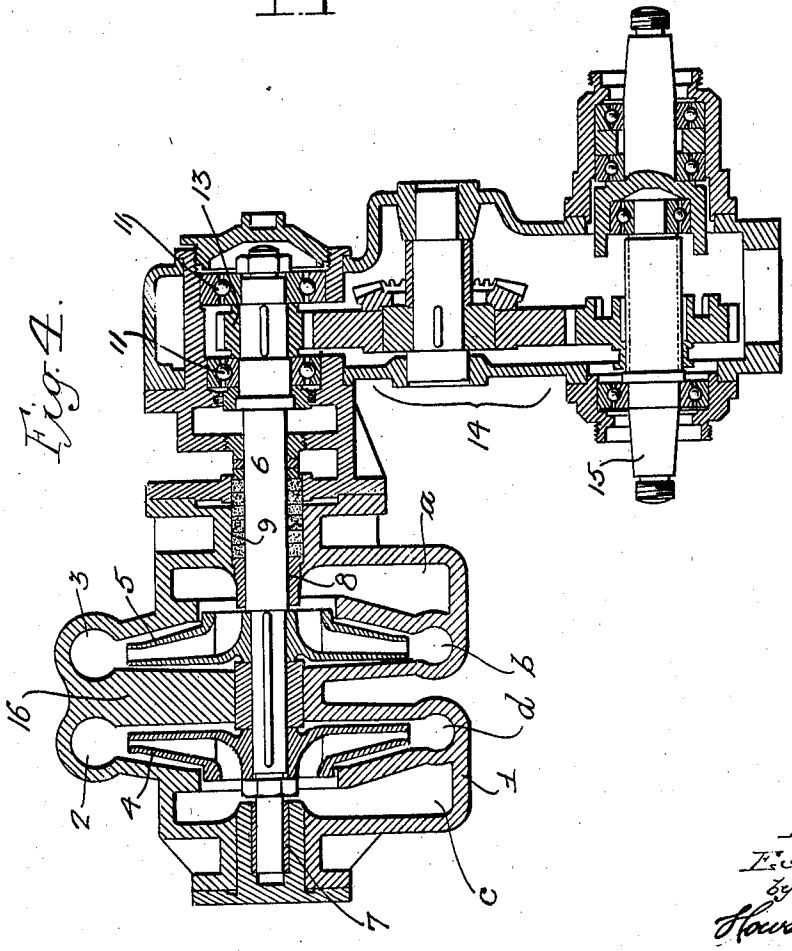


Fig. 4.



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UNITED STATES PATENT OFFICE

2,045,505

CENTRIFUGAL PUMP

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Application July 6, 1934, Serial No. 734,025

3 Claims. (Cl. 103—106)

This invention relates to improvements in centrifugal pumps, and more particularly to pumps of a type adapted for use in fire extinguishing apparatus.

The underwriters' requirements for fire pumps necessitate a wide range of pressures beyond the capacity of centrifugal pumps of standard design, and it is an object of my invention to provide a centrifugal pump affording a relatively wide range of pressure and so designed and constructed as to meet all the exacting requirements of use in fire apparatus.

Another object of the invention is to improve the operating characteristics of multi-stage pumps of the stated type, as hereinafter specifically set forth.

To the above general end, a specific object of the invention is to provide a multi-stage serial-parallel pump having a relatively high maximum capacity in the series relation.

A further specific object is to provide a multi-stage pump having stages of different capacities wherein the construction is such as to secure a theoretically substantially perfect hydraulic balance.

Figure 1 is a side elevational view of a pump made in accordance with my invention;

Fig. 2 is a top plan view of the pump;

Fig. 3 is a section on the line 3—3, Fig. 2;

Fig. 4 is a transverse section on the line 4—4, Fig. 1;

Fig. 5 is a sectional view on the line 5—5, Fig. 1, and

Fig. 6 is a transverse sectional view of a multi-stage pump illustrating a modification within the invention.

With reference to the drawings, the pump illustrated in Figs. 1 to 5, inclusive, comprises a casing 1 having intermediate its ends volute chambers 2 and 3 for a pair of centrifugal impellers 4 and 5 respectively. These impellers, which are illustrated in Figs. 3 and 4, are mounted upon a common shaft 6, which is journaled in bearings 7 and 8 in the casing and projects through the casing at one end, see Fig. 4, to provide for connection therewith of a motor (not shown). A suitable stuffing box 9 is provided to seal the joint between the shaft and the casing, and the outer end of the shaft is mounted in anti-friction bearings 11 in a casing extension 12. Between these bearings the shaft carries a pinion 13 which meshes with a gear train designated generally by the reference numeral 14 constituting a transmission between the shaft and the motor.

The chambers 2 and 3 are separated by a partition 16 which projects beyond the chambers at both sides and terminates adjacent the ends of the casing 1, the latter being open to provide alternative selective suction ports, 17 and 18, for the pump. The partition extensions form in effect parallel passages extending longitudinally of the casing and intermediate their ends communicating respectively with the chambers 2 and 3, the corresponding ends of both passages having communication with the respective casing suction ports 17 and 18. The casing in practice is adapted for mounting transversely upon the chassis of a motor vehicle, the longitudinal frame pieces of which are indicated at 30, and the construction described above affords suction ports available at both sides of the vehicle. The terminal ends of the casing 1 embracing the ports 17 and 18 are threaded in the present instance to provide for attachment thereto either of caps closing said ports or of a suction duct communicating with the source of fluid supply.

At the top of the casing, the chambers 2 and 3 communicate respectively with passages 21 and 22 which extend more or less tangentially from the upper parts of the chambers, the passages 21 and 22 terminating in a common discharge port 23. As illustrated in Figs. 3 and 5, flow in the passage 22 is controlled by means of a rotary valve 24, this valve in one position and as shown in Fig. 3 permitting a direct flow from the passage 22 to the discharge 23. In this position, the valve 24 also closes the upper end of a passage 25 which extends downwardly from the passage 22 at a point adjacent its outer end to the suction passage at one side of the partition 16 that communicates with the chamber 2. At the opposite ends of this passage, designated in Figs. 2 and 3 by the reference numeral 26, are placed check valves 27 and 28, respectively, these valves turning inwardly and permitting inflow from the ports 17 and 18 to the chamber 2, while preventing flow in the reverse directions. By adjusting the valve 24 in obvious manner, this valve may be made to disconnect the passage 22 from the discharge 23 and to connect the passage with the bypass 25, and through the chamber 26, with the chamber 2.

Operation of the pump is as follows: Assuming the suction port 18 closed and the suction port 17 connected with a suitable source of fluid supply, operation of the impellers 4 and 5 results in a flow of fluid from the source through the port 17 to the chambers 2 and 3 simultaneously, the inflow dividing to opposite sides of the partition 16 and the check valve 28 offering no ob-

struction to flow of the fluid to the chamber 2. The fluid is projected by the impellers from the chambers 2 and 3 into the passages 21 and 22 respectively, and with the valve 24 in the position shown in Fig. 3, both passages 21 and 22 discharge to and through the main pump discharge port 23. The rotors thus operate in parallel and effect a discharge of a relatively large volume at a relatively low pressure.

Assuming now requirement for a higher discharge pressure, the valve 24 is adjusted to its alternative position in which the flow from the chamber 3 through the passage 22 is diverted through the bypass 25 into the passage 26, which as previously set forth communicates with the chamber 2. The resulting pressure within the passage 26 and in the chamber 2, being greater than the pressure at the intake 17, closes the valves 27 and 28, thus preventing flow of fluid from the intake 17 directly to the chamber 2. The entire volume of fluid entering the pump casing, therefore, passes directly to the chamber 3 and the impeller 5, thence through the passage 22 and bypass 25 to the chamber 2 and the impeller 4, and thence through the passage 21 to the discharge 23, the impellers 4 and 5 thus operating in tandem and effecting a corresponding increase in the discharge pressure.

It will be noted by reference to Fig. 4 that the impellers 4 and 5 are of unequal volume capacities and that the capacity of the impeller 5 exceeds that of the impeller 4. The impellers preferably are so designed, however, that while their volume capacities differ, they possess the same pressure-creating ability. In the conventional multi-stage pump having impellers of equal capacities, it has been found that the efficiency drops rapidly beyond the normal capacity of the impellers, and that at a definite point no greater volume can be obtained. The relationship of this point to the normal capacity may vary in different types of design, but for a given type, it will remain substantially fixed. I have discovered that the maximum capacity of a pump wherein the stages are designed for differing capacities is materially greater than the maximum capacity of a pump having stages designed for equal capacities and for the same total capacity as the pump of unequal stages. Assume for example that in a uniform stage pump having a normal capacity of 500 gallons, the maximum capacity under a given set of conditions is 120% or 600 gallons; then the maximum capacity of a pump having stages designed, say for 600 and 400 gallons respectively, would be 720 gallons under the same conditions. The higher the lift or the lower the pressure at the entrance of the first stage, the more pronounced does this difference in efficiency become. This peculiar characteristic is of particular value in multi-stage serial-parallel pumps of the type described above, and particularly in pumps of that character employed in fire engines, since while the maximum capacity is materially increased, the efficiency of the pump when operating in parallel is not only not impaired but in some instances is actually improved. The flexibility of the pump and its general characteristics are thus materially improved without material sacrifice of weight and dimension factors.

It will be noted further by reference to Fig. 4 that while the capacities of the impellers 4 and 5 differ as described, the impellers are so designed and arranged that in spite of the difference in capacities, there is obtained a theoretically perfect hydraulic balance within the pump. The impellers are so formed that the surface areas thereof exposed to fluid pressures within the casing are equal, and while the fluid pressures to which the impellers are respectively subjected differ materially, the differential of the opposed pressures acting on opposite sides of the respective impellers is the same. With the pump operating in parallel, the pressures imposed upon the two impellers are the same and no unbalance exists. Assuming that with the impellers operating in series the pressure in the intake chamber *a* is of zero value and the pressure in the impeller chamber *b* is 100 units, it will be apparent that the pressure in the intake chamber *c* of the impeller 4 will also be 100 units, and since the pressure-creating ability of the two impellers is the same, the pressure in the impeller chamber *d* will necessarily be 200 units. The differential pressure applied to the two impellers tending to force the impellers away from each other will thus be in each case 100 units, and the assembly is thus balanced.

In Fig. 6, I have illustrated this same principle as applied to a series multi-stage centrifugal pump having different stage capacities and wherein the impeller shaft projects through the pump casing at both ends. It will be apparent that this principle of balance may be equally well applied to any multi-stage pump of this character having an even number of stages of the same pressure-creating ability.

A pump made in accordance with my invention and the principles set forth above is relatively simple structurally, inexpensive to manufacture, and possesses a high operating efficiency. An important characteristic of the pump is the extreme compactness of form and the adaptability thereof to use in fire-engines of the standard types.

I claim:

1. In a series parallel centrifugal pump, a casing comprising an integral casting forming the foundation of the pump structure and containing the lower portions of a pair of axially aligned and separate impeller chambers together with a pair of substantially parallel and adjoining suction passages each extending inwardly from both of the opposite ends of said casting and respectively to the relatively remote axial ends of said chambers, a check valve in each end of one of said suction passages operable to permit flow only toward the associated impeller chamber; and a superimposed casing section containing the upper portions of said chambers together with discharge passages therefor extending above the said suction passages and including a hollow extension connected at its underside to the said foundation casting and forming a bypass between the discharge passage of one of the chambers and the suction passage of the other of said chambers, said other chamber being that one whose suction passage is provided with the check valves and said bypass communicating with said passage at a point between said valves, and a valve in said bypass operable to permit series or parallel operation of the impellers.

2. In a series parallel centrifugal pump, a casing comprising an integral casting forming the foundation of a pump structure and containing the lower portions of a pair of axially aligned and separate impeller chambers together with a pair of substantially parallel and adjoining suction passages extending respectively to the relatively remote axial ends of said chambers; a

superimposed casing section containing the upper portions of said chambers together with discharge passages therefor extending above the said suction passages and including a hollow extension connected at its underside to said foundation casting, and forming a bypass between the discharge passage of one of the chambers and the suction passage of the other of said chambers, a suction port fitting secured to each end of the foundation casting and embracing the adjacent ends of both passages, said fittings comprising partition elements dividing the inner ends of the fitting passages into two sections forming respectively continuations within the fittings of the said suction passages; check valves mounted in the casing at the inner ends of said fittings and controlling the connections between the interior of said fittings and that one of the suction passages of the foundation casting to which said bypass connects, the inner ends of said fittings being formed to provide seats for said check valves; and a valve member mounted in the casing at the junction of said bypass with the discharge passage for controlling the connection of said passage with the bypass.

3. In a series parallel centrifugal pump, a casing comprising an integral casting forming the foundation of the pump structure and containing the lower portions of a pair of axially aligned and separate impeller chambers together with a pair of substantially parallel and adjoining suction passages extending respectively to the relatively remote axial ends of said chambers; a superimposed casing section containing the upper portions of said chambers together with discharge passages therefor extending above the said suction passages and including a hollow extension connected at its under side to the said foundation casting and forming a bypass between the discharge passage of one of the chambers and the suction passage of the other of said chambers; a suction port fitting secured to said foundation casting and embracing the outer ends of both of the said suction passages, said fitting comprising a partition element dividing the inner end of the fitting passage into two sections forming respectively continuations within the fitting of the said suction passages; a check valve mounted in the casing at the inner ends of said fittings and controlling the connections between the interior of said fitting and that one of the suction passages of the foundation casting to which said bypass connects, the inner ends of said fittings being formed to provide a seat for said valve; and a valve element mounted in the casing at the junction of said bypass with the discharge passage and controlling the connection of said passage with the bypass.

EVERT J. WENDELL.