June 19, 1956 D. F. THOMAS ET AL 2,750,893

FIRE PUMP

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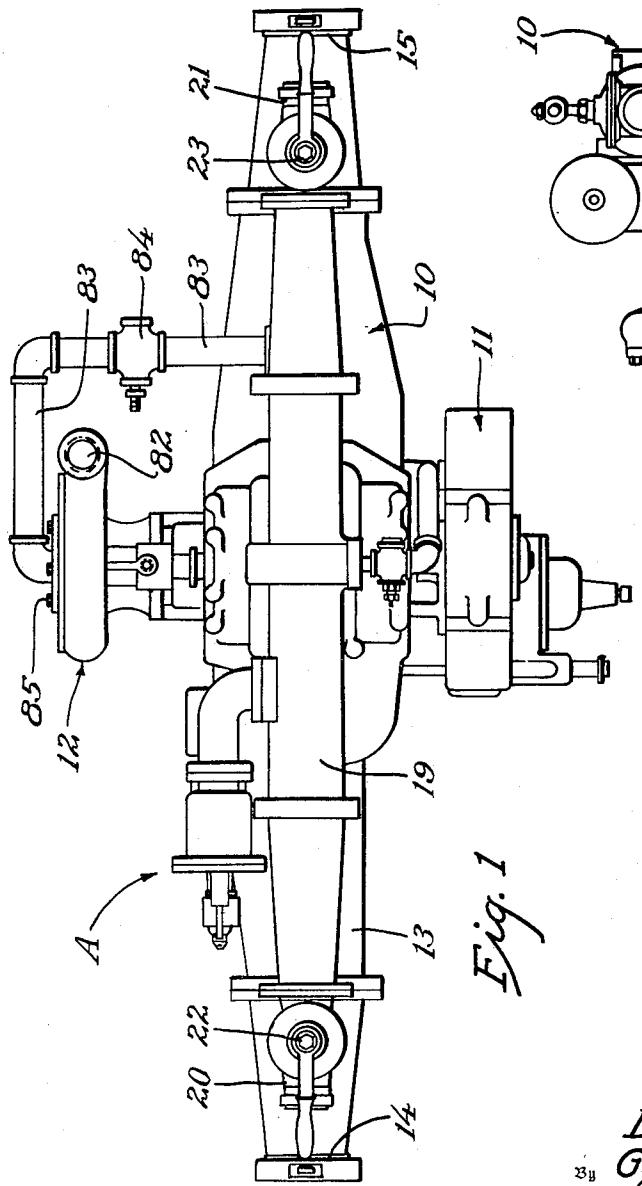


Fig. 1

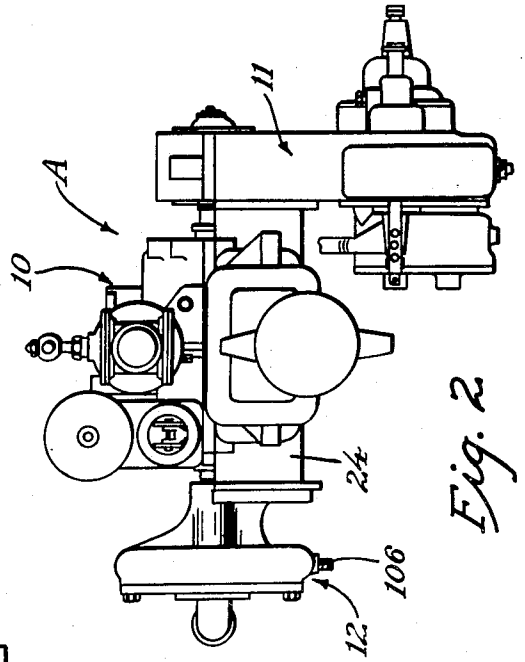


Fig. 2

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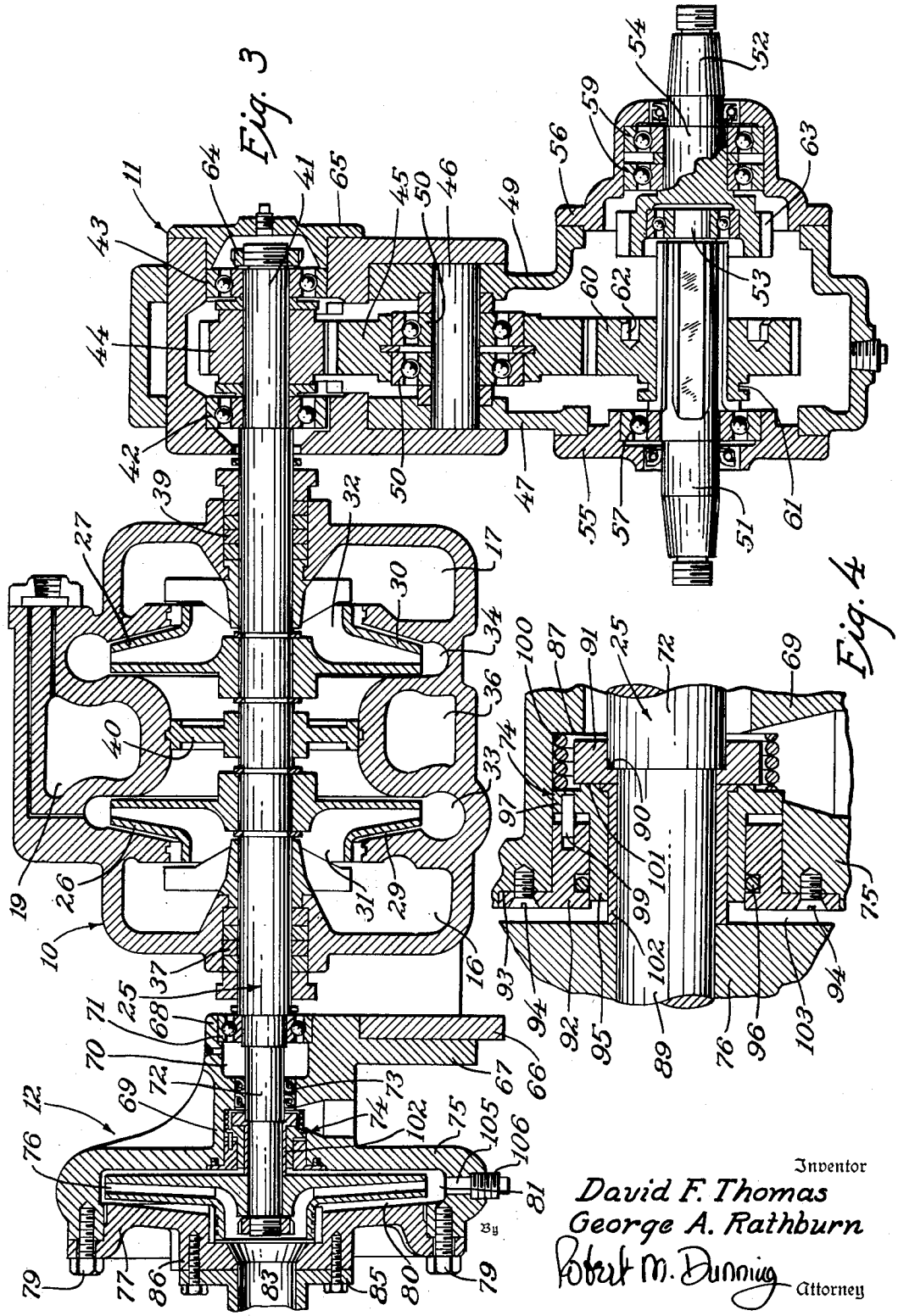


Fig. 3

Fig. 4

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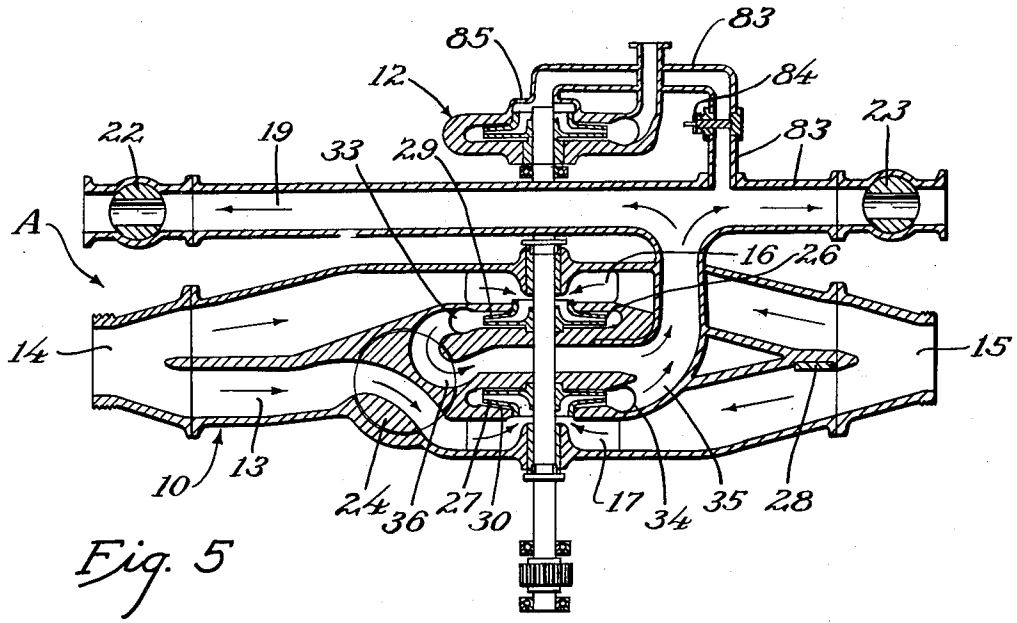


Fig. 5

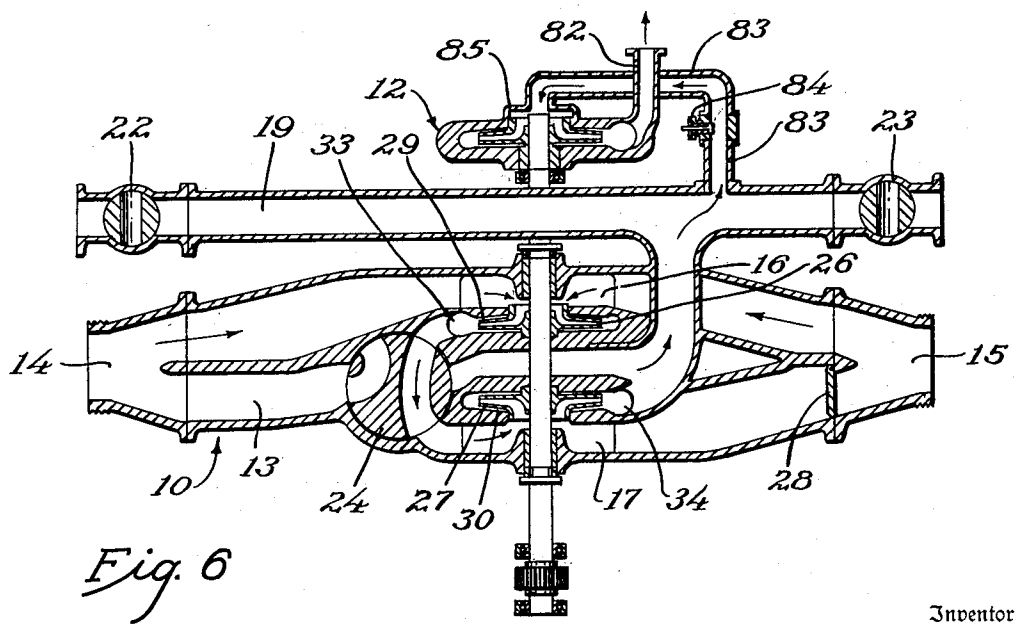


Fig. 6

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FIRE PUMP

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4 Claims. (Cl. 103—106)

The present invention relates to an improvement in fire pumps and deals particularly with a multi-stage pump having a last stage which may or may not be employed.

In the production of centrifugal pumps of the type used in fire fighting apparatus and the like, the use of unusually high pressures is sometimes required. During the normal operation of the pump sufficient pressure may often times be built up to serve to best advantage in fighting the fire. However, from time to time increased pressure at the outlet of the pump is desirable, such as would be the case in dealing with a fire on an unusually high structure where the stream of water must be unusually long or where a finely divided stream of water, known as mist or fog, is desired. Under such circumstances, it is often highly desirable to be able to employ an additional stage which will increase the discharge pressure of the pump materially.

An object of the present invention lies in the provision of a pump preferably having a plurality of impellers and which if desired may be connected either in series or in parallel. An additional impeller rotates in unison with the plurality of impellers, the additional impeller under ordinary circumstances rotating freely within its empeller chamber. When it becomes necessary to employ an additional stage on the pump to develop a higher pressure, the normally operable impellers are connected in series and the last impeller of the series is connected to the intake of the normally unused impeller. As a result higher pressures can be developed almost instantaneously when desired without the necessity of providing costly clutches or similar means.

A feature of the present invention lies in the provision of a centrifugal pump having a pump housing normally enclosing two or more impellers and in providing means whereby these impellers may be connected in series. An auxiliary pump housing is secured to the first mentioned pump housing in such a manner that the impeller shaft of the main pump extends into the impeller chamber of the auxiliary pump housing. When the auxiliary pump is not in use the impeller thereof rotates freely in its housing. However, when additional pressure must be developed the outlet of the main pump housing is connected to the intake of the auxiliary pump housing and the impeller of the auxiliary pump acts to increase the pressure developed by the pump.

An added feature of the present invention lies in the provision of a pump having a main pump housing employing two or more impellers rotatably supported upon an impeller shaft and in providing a gear case or transmission for driving this impeller shaft. The gear case is mounted on one side of the main pump housing while an auxiliary pump casing is mounted upon the opposite side thereof. With this construction the normally unused impeller is mounted in close relation to the main pump and does not interfere with the normal use, operation, or repair of the main pump or the gear box.

The main pump housings are usually formed in at least two parts which are separable along a horizontal division line extending through the impeller shaft. As a result if the repair or replacement of any part of the main pump is required, the top portion of the pump may be disengaged from the bottom portion thereof so that the impeller chambers and the impeller shaft are exposed. The gear box is usually produced with removable sides or removable side plates which support impeller shaft bearings as well as bearings for the other shafts supporting the gears. If the auxiliary stage of the pump is attached to the gear box so as to project from the gear box in a direction opposite the main pump housing, this auxiliary housing must be dismantled or removed before access to portions of the interior of the gear casing may be obtained. However, by mounting the auxiliary pump housing on the side of the pump housing opposite that connected to the gear housing, either the main pump housing, the gear housing, or the auxiliary pump housing may be dismantled without interference with other portions of the structure. As a result with this arrangement considerable time and effort is saved in the repair and maintenance of the pump.

An added feature of the present invention lies in the fact that by mounting the auxiliary pump stage on the opposite side of the main pump casing from the gear box, the danger of water leaking into the gear case is obviated. In order to get proper support the housing of the auxiliary pump must be mounted either to the main pump housing or to the gear case. Where the auxiliary pump housing is mounted to the gear case, there is danger of water leaking along the shaft from the auxiliary pump into the gear case. By locating the added stage on the side of the main pump housing opposite to the gear case, all such danger is obviated.

An added feature of the present invention lies in the simplicity with which attachments such as a priming pump clutch or tachometer drive may be made. If such an added element is used, it is desirable to secure this added element to the gear case. If the added auxiliary pump housing is connected to the gear case the connection with such attachments is materially complicated.

An additional feature of the present invention lies in the fact that by mounting the adding auxiliary pump housing on the side of the main pump housing opposite to the gear case, a better weight distribution is obtained and the resulting unit is more compact. Pumps of the type described are usually supported on the frame or chassis of the mounting through suitable mounting pads integral with the main pump housing. By locating the gear case on one side of this main housing and mounting the auxiliary pump stage on the opposite side thereof a better balance of weight is obtained.

These and other objects and novel features of our invention will be more clearly and fully set forth in the following specification and claims.

In the drawings forming a part of our specification:

Figure 1 is a top plan view of a fire pump showing the construction thereof.

Figure 2 is an end elevational view of the pump illustrated in Figure 1.

Figure 3 is a cross sectional view through the pump shown in Figures 1 and 2.

Figure 4 is an enlarged sectional detail of the seal between the auxiliary stage and the impeller shaft.

Figure 5 is a diagrammatic view of the pump showing the first two stages arranged in parallel and with the third stage inoperative.

Figure 6 is a diagrammatic view similar to Figure 5 showing the first two stages in series and connected to the third stage.

The pump A is best seen in its entirety in Figures 1 and 2 of the drawings. The pump A includes a main pump housing 10 which is of elongated form and includes an

inlet and an outlet at both ends of the housing. The gear case for driving the pump is indicated in general by the numeral 11 and is connected to one side of the main pump housing 10 as shown in Figures 1 and 2. The auxiliary pump housing or added final stage is indicated in general by the numeral 12 and is located on the side of the main pump housing opposite the side to which the gear case 11 is secured.

The pump A includes an intake manifold 13 which extends from end to end of the pump housing 10 and includes opposed inlet passages 14 and 15. These inlet passages 14 and 15 communicate with inlet chambers 16 and 17 (see Figures 3 and 5) when the pump impellers are in parallel. The pump also includes an outlet manifold 19 which is provided with oppositely directed outlet ports 20 and 21. These ports 20 and 21 are controlled by valves 22 and 23 respectively. The outlet manifold 19 and the inlet manifold 13 are generally parallel in relation.

A by-pass arrangement is provided between the outlet of one impeller and the inlet of the other impeller, the arrangement being generally similar to that illustrated in Patent No. 2,207,575 issued July 9, 1940, to R. R. Boyles et al. This by-pass is controlled by a valve 24, which tends to close the passage from one intake chamber 17 to one end of the intake manifold 13. A check valve 28 closes the other side of the chamber 17 to isolate this chamber from the intake manifold. Thus the pump A includes two stages which may be arranged in series or in parallel and the detail structure of the passage arrangement which makes this arrangement possible is not illustrated in view of the fact that it is generally old in the art, as indicated in the above mentioned patent.

With reference to Figure 3 of the drawings it will be noted that the impeller shaft 25 extends horizontally through the main pump housing 10 and acts as a support for a pair of impellers 26 and 27. The impellers rotate with the shaft 25 and are keyed or otherwise connected thereto. The impellers 26 and 27 are mounted within impeller chambers 29 and 30 respectively and are shaped to receive liquid from the intake chambers 16 and 17 through ring shaped openings 31 and 32 encircling the shaft 25. The impellers 26 and 27 direct fluid into volutes 33 and 34 encircling the impellers and suitable passage means connect the volutes with the discharge manifold 19. As has been previously described a by-pass extends from the discharge of volute 33 to the inlet chamber 17 of the impeller 27 which is controlled by a suitable valve for connecting the impellers either in series or in parallel.

Figure 5 diagrammatically illustrates the pump A in position for parallel operation. The liquid may enter either end of the intake manifold 13 through either the port 14 or the port 15, or both. This liquid is drawn into the intake chambers 16 and 17 and into the impellers 26 and 27. The impeller 26 directs fluid through its volute 33 and into a by-pass leading to the transfer valve 24. The valve 24 directs fluid through the discharge passage 36 into the discharge manifold 19.

The impeller 27 directs fluid through its volute 34 and through the discharge passage 35 into the discharge manifold 19.

In Figure 6 of the drawings the pump is arranged for series operation. In this arrangement the liquid may enter the inlet manifold 13, through either inlet port 14 or 15, into the intake chamber 16. This liquid is drawn into the impeller 26 and forced thereby into the volute 33 which directs the fluid from the first stage through the transfer valve 24. In this position the transfer valve closes the communication between the suction chamber 17 and one side of the intake manifold 13 and directs fluid from the volute 33 to the suction chamber 17. This fluid under pressure causes the suction check valve 28 to close so that the suction chamber is disconnected from the intake manifold 13 at both ends thereof.

The impeller 27 directs fluid through the volute 34 and into the discharge passage 25 connected to the discharge manifold 19.

A suitable bearing and packing gland 37 extends into one side of the main pump housing 10 and a similar packing gland 39 extends into the opposite side thereof. These packing glands prevent the leakage of fluid from the inlet passages in the operation of the pump. An intermediate partition wall 40 encircles the shaft 25 intermediate the impellers 26 and 27 so as to separate the impeller chambers 29 and 30. The gear case 11 may be formed as best illustrated in Figure 3 of the drawings. One end 41 of the shaft 25 is reduced in diameter and is supported by spaced bearings 42 and 43 within the body of the gear case. A gear 44 is mounted on the shaft end 41 between these bearings. The gear 44 is in mesh with an idler gear 45 supported upon a counter-shaft 46 fixed between the side walls 47 and 49 of the gear case. Bearings 50 are supported by the counter-shaft 46 and rotatably support the gear 45.

A drive shaft 51 extends into the lower end of the gear case 11 and is arranged in axially aligned relation to a driven shaft 52. The drive shaft 51 is provided with a reducer diameter end 53 which is supported by a bearing 54 mounted in the driven shaft 52. In this way the shafts 51 and 52 are held in proper alignment and may rotate in unison or the drive shaft 51 may rotate freely relative to the driven shaft 52. The combined shafts 51 and 52 extend through opposed closure plates 55 and 56. A bearing 57 supported by the closure plate 55 and a pair of bearings 59 mounted within the closure plate 56 act to support the combined shafts.

A gear 60 is spline connected to the drive shaft 51 and is slidable longitudinally thereon, being moved by means of a suitable shifting fork acting in groove 61 integral with the gear 60. When the gear 60 is in the position illustrated in Figure 3 of the drawings, the drive shaft 51 is connected to the impeller shaft 25 through the gears 60, 45, and 44. However, when the gear 60 is moved longitudinally on the shaft 51, internal gear teeth 62 engage external gear teeth 63 on the driven shaft 52 so as to drive the shafts 51 and 52 in unison. It will be noted that the gear 60 may be moved to intermediate position in which it is disengaged both from the gear 45 and from the gear teeth 63.

The construction described is all generally old in the art and is similar to constructions covered by previous patents. The important feature of the present invention lies in an addition to the construction just described.

It will be noted that the gear 44 is held in place on the end 41 of the impeller shaft 25 by means of a lock nut 64 or other such device. The gear casing 11 is usually provided with an end closure plate 65 which encloses the end of the shaft 25 and seals the gear case against the entry of dirt or dust. In the past this end plate 65 has been removed and an auxiliary pump stage connected at this point. Such a construction has certain advantages, but also has serious disadvantages. One such disadvantage lies in the fact that leakage along the shaft 25 from the third stage would cause a leakage of water into the gear casing. Serious damage to the gears and bearings may then readily result. It will be noted that the gear case and main pump housing are spaced so that leakage of water through the packing 39 will not enter the gear case. Such a construction could be used in attaching the third stage, but the resulting construction would be somewhat more complicated and somewhat more costly to produce than the construction described herein, and it would require more space.

The pump housing 10 is provided with an integral flange 66 to which the auxiliary pump housing 12 is attached. The housing 12 includes a flange 67 designed to extend along the flange 66 and to be secured thereto by any suitable means such as bolts, cap screws or the like. The auxiliary pump housing 12 includes a hub portion 69 having a relatively large diameter opening 70 in one end

thereof for accommodation of a bearing **71** held in place by a shoulder **68**. The opening **70** also accommodates oil for lubricating the shaft. The bearing **71** encircles a portion of the shaft **25** and assists in supporting this shaft.

A reduced diameter portion **72** of the shaft **25** extends through a pair of seals **73** which tend to prevent the leakage of moisture along the shaft. A sealing unit **74** also encircles the shaft **25** and will later be described in detail. The housing **12** includes an outwardly directed flange **75** which extends outwardly alongside of the impeller **76**. A closing plate **77** is bolted or otherwise affixed by cap screws **79** to the main portion of the pump casing **12**. An impeller chamber **80** is provided between the closure plate **77** and the main body of the housing **12**, to accommodate the impeller **76**. A volute **81** encircles the impeller **76** and communicates with a discharge pipe **82** best illustrated in Figure 1 of the drawings.

A pipe **83** communicates with the discharge manifold **19** and is provided with a shut-off cock **84**. The pipe **83** extends angularly to a point adjacent to the axis of the auxiliary pump **12** and is provided with an attaching flange **85** by means of which it is connected to the hub **86** of the closure plate **77**.

The seal used in conjunction with the auxiliary pump unit **12** is best shown in Figure 4 of the drawings and forms an important feature of the present invention. The hub portion **69** is provided with an internal shoulder **87** intermediate its ends. The shaft **25** is provided with a reduced diameter portion **89** outwardly of the reduced diameter portion **72** forming a shoulder **90** between the two parts of different diameter. A ring **91** is provided with an internal aperture of two diameters to snugly fit the shaft portions **72** and **89** and to engage against the shoulder **90**. The ring **91** thus forms a seal with respect to the shaft **25** and is held from axial movement in one direction.

Obviously the ring **91** is sealed to and rotates with the shaft **25**. A retaining ring **92** is provided with a peripheral flange **93** connected to the auxiliary pump housing **12** by flat head screws **94** or other suitable means. The retaining flange **92** is thus sealed to the body of the auxiliary pump housing and fits snugly within the bore of the housing hub **69**. A sleeve **95** is slidably supported inwardly of the ring **92** and is sealed with respect thereto by an O-ring **96** or by other suitable sealing means. A peripheral flange **97** is provided on the sleeve **95** which extends outwardly into sliding fit relation with the internal bore of the hub **69**. Pins **99** or other suitable means are provided for preventing relative rotation between the ring **92** and the sleeve **95**. Accordingly the sleeve **95** is held from rotative movement, but is free to slide axially with respect to the shaft **25**.

A spring **100** is interposed between the flange **97** of the sleeve **95** and the fixed shoulder **87** in the housing hub. The spring **100** tends to urge the sleeve **95** to the left as viewed in Figure 4 of the drawings. A short sleeve like projection **101** on the flange **97** slidably engages the ring **91** in one extreme position of the sleeve **95**. In the other extreme position the projection **101** is spaced from the ring **91** so as not to contact the same. A spacing ring **102** extends between the impeller **76** and the ring **91** so as to space these elements and to hold them in proper relationship. The spacing ring **102** fits within the sleeve **95** freely enough so that the sleeve **95** may move longitudinally of the shaft **25**. It will be noted that a space **103** is provided between the impeller **76** and the flange **75** of the housing **12**. As a result when the impeller **76** is in operation pumping liquid from its intake pipe **83** to the outlet connection **82**, water under pressure will extend through this space **103** and urge the sleeve **95** to the right as viewed in Figure 4. As a result the sleeve projection **101** will seal against the ring **91** and a running seal will be provided past which liquid will not leak to any material extent. On the other hand when the supply of water is cut off from the intake pipe **83** the impeller **76** will merely rotate within its chamber without producing any liquid pumping operation and the pressure will be relieved in the space **103**. As a result the spring **100** will force the sleeve **95** out of sealing relation with the ring **91** and the ring may revolve freely without contacting the running seal. Thus the seal will not become over-heated through sliding contact when the impeller **76** is not in the operation of pumping liquid and at the same time the seal will be automatically protected as soon as liquid enters the impeller chamber.

It will be noted that our construction accomplishes certain definite purposes and has advantages over other more complicated structures. In the past the third stage has been mounted upon the gear case where there is likelihood of water leakage into the gear case and where more of the structure must be dismantled for inspection or repair. The present construction is economical to produce as no clutch structure is required between the impeller shaft and the auxiliary stage. The impeller of the added stage operates continuously with the impeller shaft, but the running seal which prevents the leakage of liquid from the added stage becomes automatically disengaged as soon as the impeller of the added stage ceases to pump liquid. A drain **105** is provided in the casing **12**, controlled by a suitable plug **106** or drain cock, so that the impeller **76** may rotate freely when the third stage is not in use.

The manner in which the pump A may be transformed from parallel operation to series operation through the use of the valve **24** has been described and is believed obvious from an examination of Figures 5 and 6 of the drawings. When it is desired to employ the third stage, the hose or other discharge pipe is connected to the discharge **82** of the auxiliary pump unit **12**. The valve **84** is operated to open communication between the discharge manifold **19** and the third stage impeller housing. The valves **22** and **23** are shut off to close the ends of the discharge manifold. The water will then flow from the discharge manifold **19** through the connecting pipe **83** to the intake of the third stage impeller **76** which acts to force the fluid into the third stage discharge at an increased pressure.

In accordance with the patent statutes, we have described the principles of construction and operation of our fire pump, and while we have endeavored to set forth the best embodiment thereof, we desire to have it understood that obvious changes may be made within the scope of the following claims without departing from the spirit of our invention.

We claim:

1. A centrifugal pump assembly including a main pump housing having a main pump discharge, a shaft extending transversely thereof, a pair of impellers on said shaft within said housing, said impellers each having an inlet and an outlet, means in said housing between the outlet of one impeller and the inlet of the other for connecting said impellers selectively in parallel or in series, an auxiliary housing connected to said main pump housing, a third stage impeller mounted upon said shaft within said auxiliary housing, an impeller chamber within said auxiliary housing having an inlet and an outlet, a passage connecting the discharge of the main pump housing with the intake of the auxiliary housing, means for selectively directing fluid through said last named passage, and a seal between said shaft and said auxiliary housing, said seal including a pair of normally spaced elements, means on said auxiliary housing holding one of said elements fixed from rotation relative thereto and means supporting the other element rotatable with said shaft, means normally urging said elements apart, one of said elements being axially movable when subjected to pressure within said auxiliary housing, said one element extending into direct communication with said auxiliary hous-

ing pressure, said elements being engageable to form a running seal when said impeller in said auxiliary housing is in liquid pumping operation.

2. A centrifugal pump and auxiliary pump assembly comprising an elongated main pump housing, an impeller shaft journalled in said housing and extending transversely thereof, first impellers thereon, a gear case secured to said housing, said gear case including drive gear means connected to said impeller shaft for driving the same, an auxiliary housing detachably secured to said main pump housing and having an inlet and an outlet, said impeller shaft extending into said auxiliary housing, intake and discharge passages for said first named impellers extending longitudinally of said main pump housing, an auxiliary impeller within said auxiliary housing and mounted on said shaft to rotate in unison therewith, a fluid connection from one of said discharge passages to the inlet of said auxiliary housing, valve means for selectively opening and closing said fluid connection, valve means for selectively opening and closing said discharge passages for said first named impellers, whereby said auxiliary impeller may run dry when said valve means in said fluid connection is closed, sealing means in said auxiliary housing encircling said impeller shaft, means operable in the absence of fluid pressure in said auxiliary housing for reducing friction between said shaft and said seal when said pump is running dry, and means operable by the presence of fluid pressure in said auxiliary housing rendering said last named means inoperable.

3. A centrifugal pump and auxiliary pump assembly comprising a main pump housing, an impeller shaft extending through said housing, impellers on said shaft within said housing intake and discharge passages for said impellers in said housing, means connected to said shaft to drive the same, an auxiliary housing detachably connected to said main pump housing, an auxiliary impeller in said auxiliary housing, inlet and outlet passages for said auxiliary impeller in said auxiliary housing, a fluid connection extending from one of said discharge passages in said main pump housing to said inlet passage in said auxiliary housing, said impeller shaft extending into said auxiliary housing and supporting said auxiliary

impeller for rotation with said shaft, means selectively opening and closing said fluid connection whereby said auxiliary impeller will run dry when said fluid connection is closed, sealing means encircling said impeller shaft within said auxiliary housing, means operable in the absence of fluid pressure in said auxiliary housing for reducing friction between said seal and said shaft when said auxiliary impeller runs dry, and means operable by fluid pressure in said auxiliary housing to render said last named means ineffective.

4. The structure described in claim 3 and in which the seal includes a pair of normally spaced elements, means on said auxiliary housing holding one of said elements from rotation relative thereto and means supporting the other element rotatable with said shaft, means normally urging said elements apart whereupon said other element may rotate freely, one of said elements being axially movable when subjected to pressure within said auxiliary housing, said last named element extending into direct communication with the pressure within said auxiliary housing, said elements being engageable to form a running seal when said impeller in said auxiliary housing is in liquid pumping operation.

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