June 9, 1925.

1,541,171

W. H. NOBLE

CENTRIFUGAL PUMP

Filed Feb. 20, 1924

4 Sheets-Sheet 1

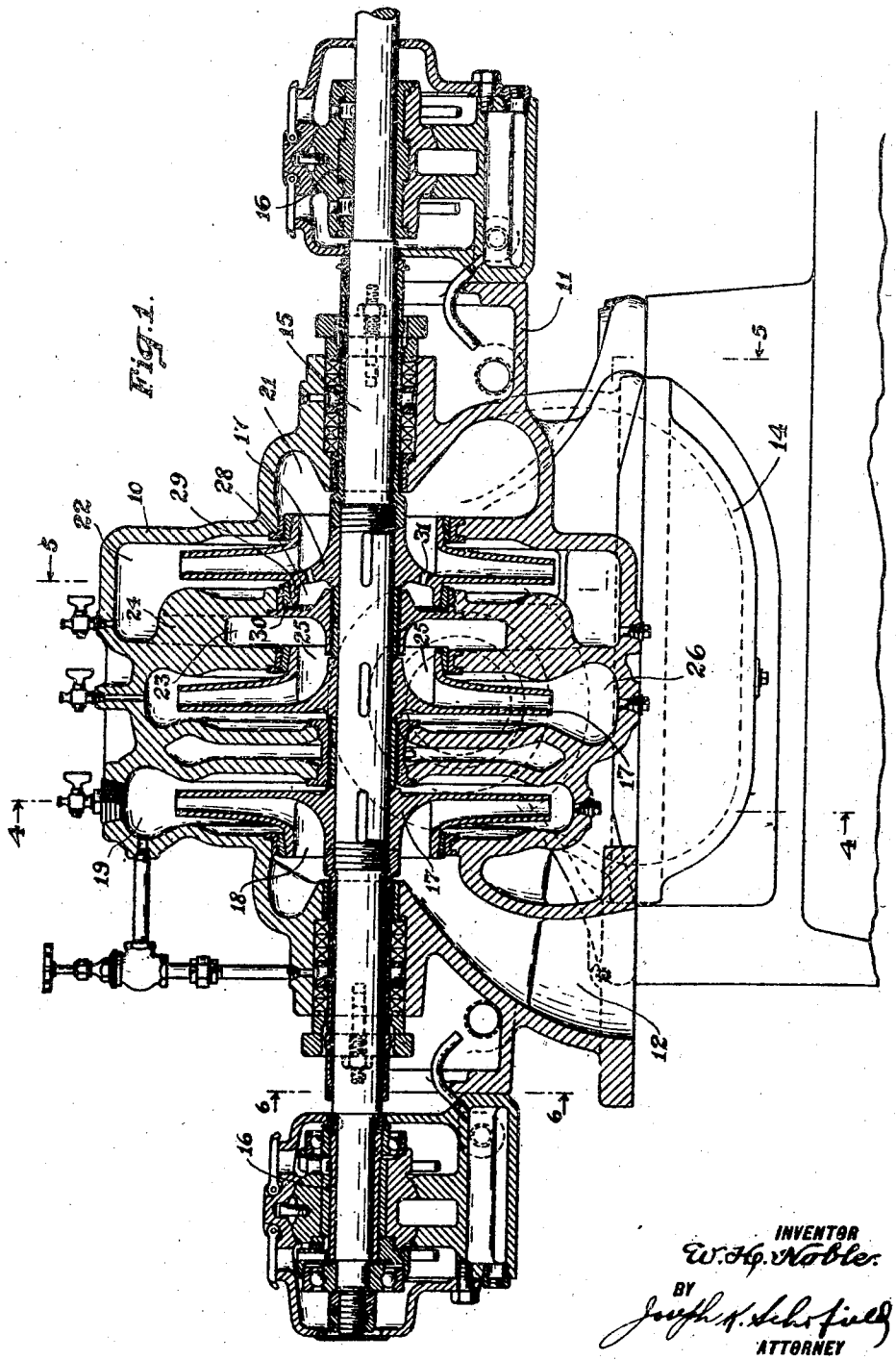


Fig. 1.

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Fig. 2.

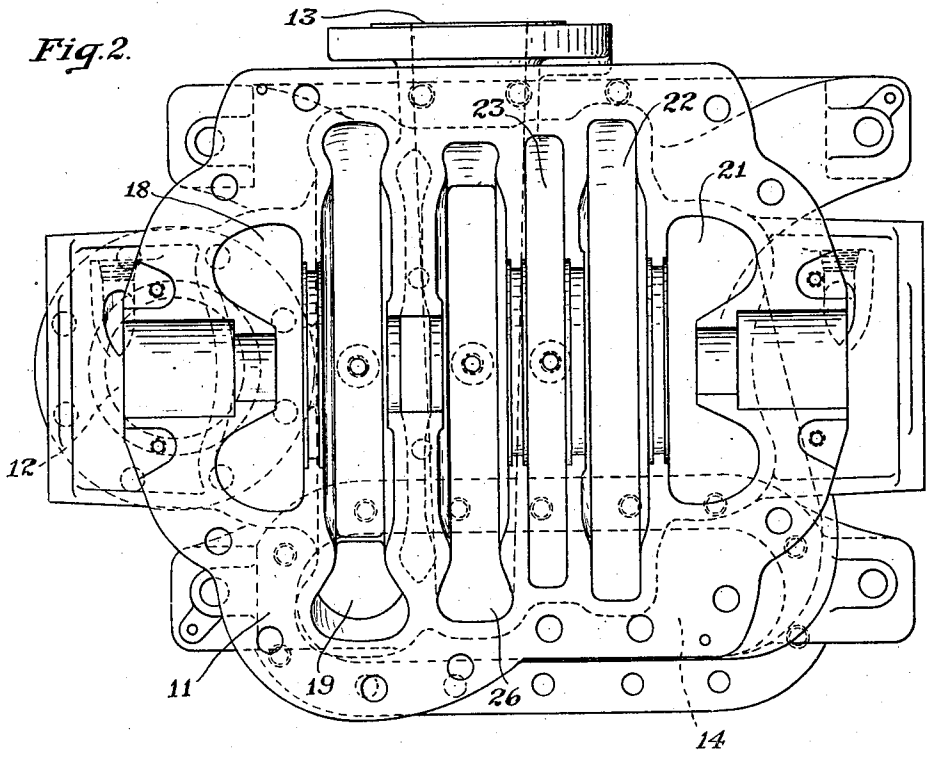
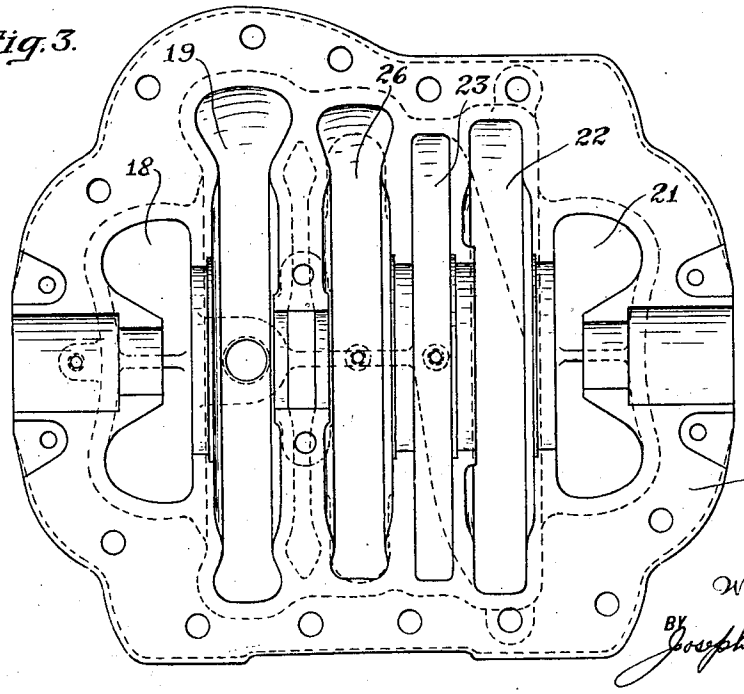


Fig. 3.



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Fig. 4.

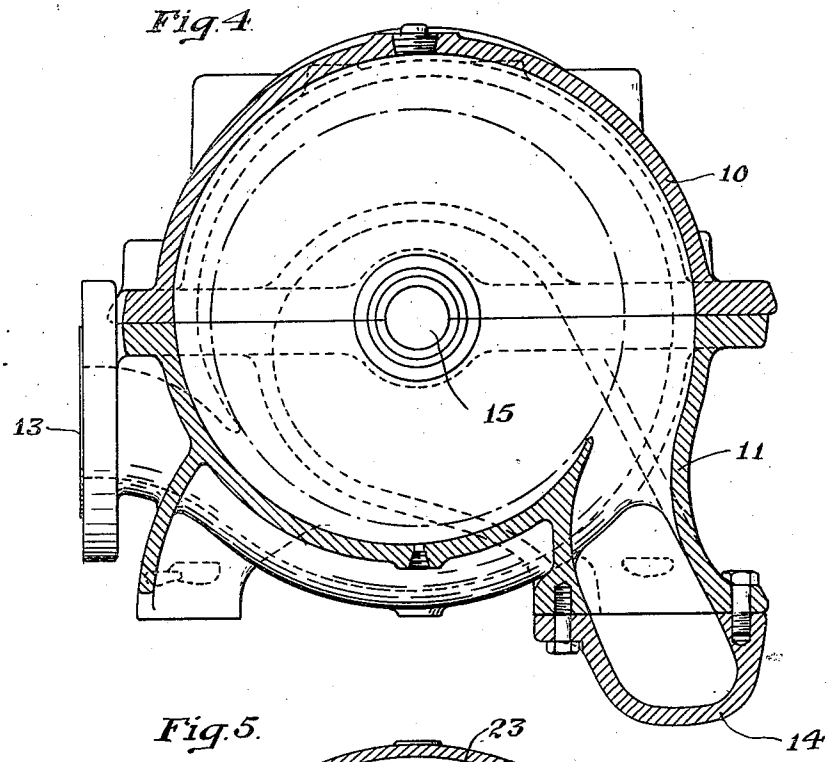
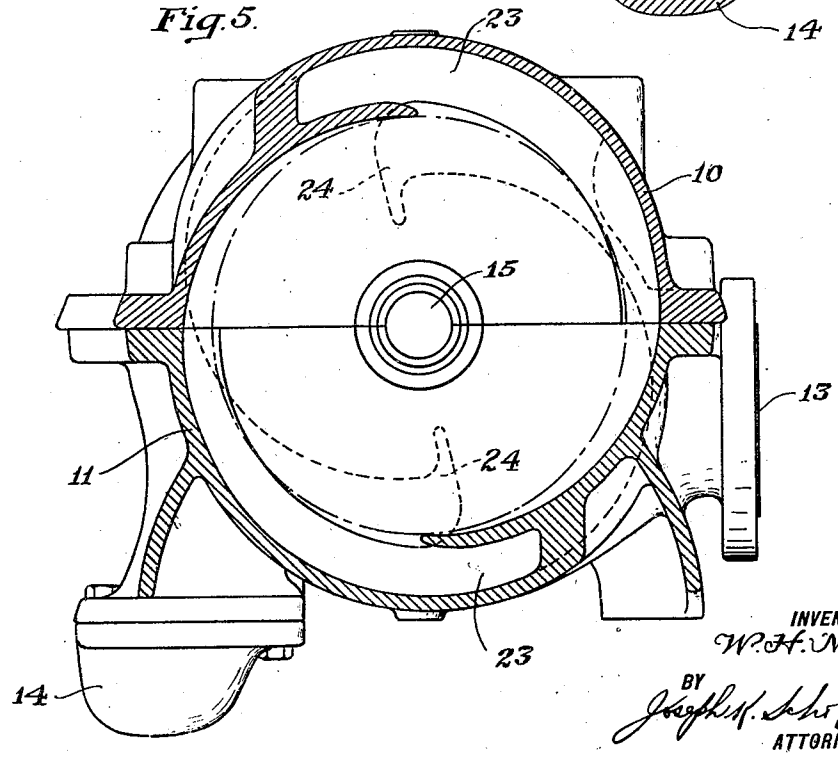


Fig. 5.



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Fig. 6.

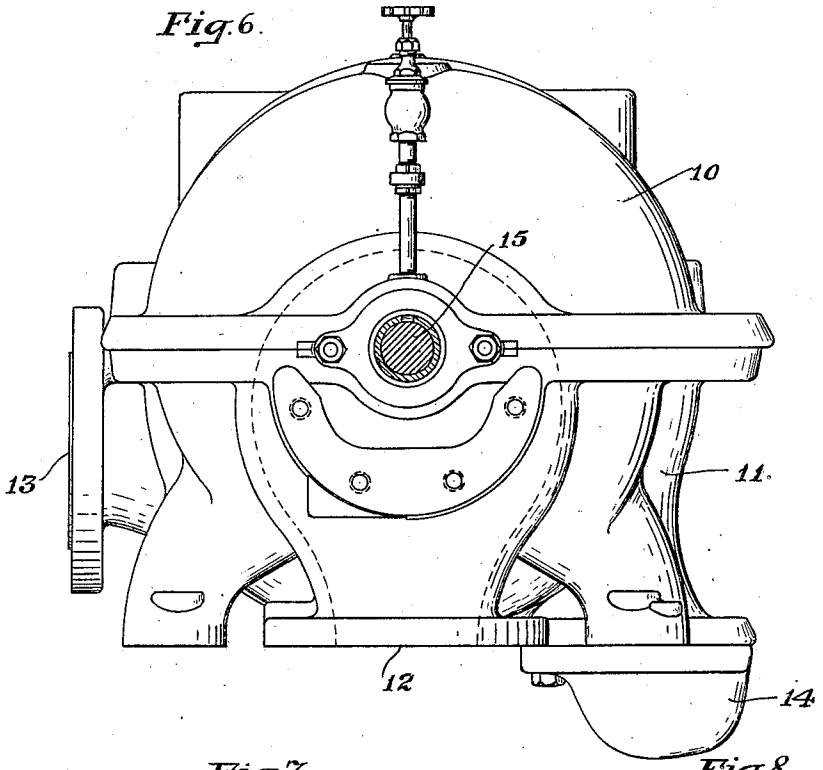


Fig. 7.

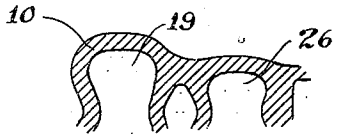


Fig. 8.

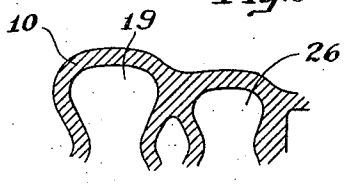


Fig. 9.

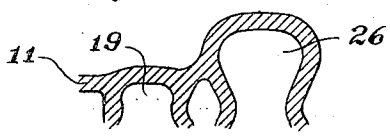
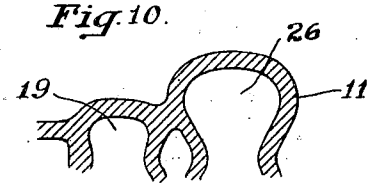


Fig. 10.



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UNITED STATES PATENT OFFICE.

WILLIAM H. NOBLE, OF EASTON, PENNSYLVANIA, ASSIGNOR TO PENNSYLVANIA PUMP AND COMPRESSOR COMPANY, OF EASTON, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

CENTRIFUGAL PUMP.

Application filed February 20, 1924. Serial No. 694,047.

To all whom it may concern:

Be it known that I, WILLIAM H. NOBLE, a citizen of the United States, residing at Easton, in the county of Northampton and State of Pennsylvania, have invented certain new and useful Improvements in Centrifugal Pumps, of which the following is a specification.

This invention relates to centrifugal pumps and particularly to a centrifugal pump having a plurality of impellers so disposed that the axial thrust of the pump may be practically perfectly counterbalanced.

It is an object of the present invention to provide a multiple stage centrifugal pump with impellers so placed that fluid passages may be arranged with a minimum interference to the flow of liquid through the pump and so that there will be no axial thrust of the impeller toward the main suction opening.

It is also an object of the present invention to provide balancing means for one of the impellers, if there is an odd number of impellers provided in the pump, and to arrange the other impellers in opposed pairs so that the axial thrust of the individual impellers may be almost entirely counterbalanced.

In the pump selected for description, there are provided three impellers two of which are placed in opposed relation to each other and the odd impeller is placed facing in the same direction as the second impeller. In this way, two of the impellers are in balance while simple balancing means may be provided for the other one.

The arrangement of the impellers is such that the odd impeller is at the end of the pump opposite the suction and, in the embodiment of the invention shown in the drawings, this impeller is separately balanced and forms the second stage of the pump. The suction of the first and second stage impellers are opposed so that these impellers are in perfect balance.

It is also an object of the invention to provide a special cross-over passage for the fluid being pumped to conduct it from the discharge of the first stage impeller to the suction of the second stage impeller. This, preferably, is in the form of the special member secured to the lower surface of the lower casing member. By this means, a passage of large section may be provided with a minimum change of direction leading to the suction of the second stage impeller at the extreme opposite end of the pump.

Finally, it is an object to provide conduits for the fluid being pumped to maintain a substantially constant velocity of the pumped fluid through the pump.

With these and other objects in view, my invention consists in the features of construction and operation set forth in the following specification and illustrated in the accompanying drawings.

In the accompanying drawings annexed hereto and forming a part of this specification, I have shown my invention embodied in a three stage, single suction impeller type of centrifugal pump, but it will be understood that the invention can be otherwise embodied and that the drawings are not to be construed as defining or limiting the scope of the invention, the claims appended to this specification being relied upon for that purpose.

In the drawings:

Figure 1 is a longitudinal sectional view showing the complete centrifugal pump.

Fig. 2 is a plan view of the lower half casing of the pump.

Fig. 3 is a plan view of the upper half casing of the pump, the half casing being shown reversed.

Fig. 4 is a transverse sectional view of the pump casing taken on line 4—4 of Fig. 1.

Fig. 5 is a view similar to Fig. 4 taken on line 5—5 of Fig. 1.

Fig. 6 is an end view of the complete pump, the left hand end being shown as viewed in Fig. 1.

Figs. 7 to 10 are sectional views showing portions of the fluid conduits in different sections of the pump.

In the above mentioned drawings, I have shown but one embodiment of the invention which is now deemed preferable, but it is to be understood that changes and modification may be made within the scope of the appended claims without departing from the spirit of the invention.

Briefly and in its broadest aspect, my invention comprises the following princi-

pal parts: first, a pump casing preferably divided horizontally into upper and lower halves; second, a plurality of impellers rotatably mounted therein upon a suitable shaft, three being shown in the form of the invention illustrated; third, a suction opening at one end of the pump casing; fourth, a volute passage forming the discharge from the first stage impeller; fifth, a cross-over conduit from the volute discharge of the first stage impeller to the suction opening for the second stage impeller at the opposite end of the pump and opposed to the suction opening of the first stage impeller; sixth, re-directing vanes or returning volutes adjacent the second stage impeller extending to the suction opening for the third stage impeller; seventh, a final volute discharge for the third stage impeller; and eighth, a balancing chamber adjacent the impeller at the opposite end of the pump, and opposed to, the suction of the first stage impeller.

Referring more in detail to the figures of the drawings, I provide a pump casing preferably formed in two parts; an upper casing and a lower casing. As shown clearly in the drawings, the casing is centrally divided horizontally, the upper and lower casing portions 10 and 11 extending from end to end of the pump. The lower casing 11 contains the suction and discharge openings 12 and 13 as well as the connections for the cross-over conduit 14.

Within the casing portions 10 and 11 is a horizontally disposed shaft 15 rotatably mounted in suitable bearings 16 and having fastened thereto the impellers 17, three being shown in the drawings. These impellers 17 when there are three or any other odd number are grouped with the end impellers back to back. The intermediate impeller (when there are but three) is placed back to back with the first impeller. When there are four impellers or stages, the intermediate ones may be opposed so that two pairs of impellers are provided, each pair balancing the axial thrust of the other pair. With five impellers, two would face in one direction and three in the opposite direction. The two extreme impellers in each case face in opposite directions with their suctions extending toward the extreme ends of the pump.

The passages or conduits for the fluid being pumped are most clearly shown in Figs. 1, 2 and 3. These are designed so that the fluid will maintain a substantially constant velocity during its passage through the pump and will have minimum sharp turns or irregular openings. The fluid enters the pump at 12 and is admitted to the intake 18 of the first stage impeller by which it is thrown into the volute 19 surrounding this impeller. From this volute 19, the fluid passes into the cross-over conduit 14 secured in any preferred manner to the lower surface of the casing portion 11. From the cross-over conduit 14, the fluid passes into the intake or suction 21 of the second stage impeller. This suction opening 21, as shown, is at the extreme opposite end of the pump. After entering this intermediate impeller, the fluid is discharged into an annular space 22 surrounding this impeller from which it passes into return volutes 23. These return volute passages 23 are formed by diametrically opposite curved vanes 24 shown in dotted lines in Fig. 5. By means of these return volutes 23, the fluid is returned to a position directly in front of the suction 25 of the third stage impeller. The third stage impeller discharges the fluid directly into a final volute 26 from which it enters the discharge opening 13.

It will be noted that the first and intermediate stage impellers are at opposite ends of the pump and that the final or high pressure stage impeller is placed in an intermediate position. This is to facilitate the flow of the fluid through the pump and simplify the parts.

Means is required to maintain one of the impellers in balance, which preferably takes the form of a balancing chamber 28. For this purpose, the intermediate stage impeller is formed with a flange 29 surrounded by a ring 30. Fluid is admitted to this chamber 28 through hole 31 bored in the impeller. The ring 30 fits the flange 29 closely but allows the shaft 15 and its impeller 17 to rotate at a high speed without undue friction. The pressure within the space 28 is substantially equal to that within the space 21 so that this intermediate stage impeller is in balance.

What I claim is:

1. A multi-stage centrifugal pump comprising in combination, a pump casing comprising upper and lower halves, more than two impellers rotatably mounted therein, two of said impellers being opposed whereby they are balanced, a suction inlet at one end of the casing, a volute discharge from the first stage impeller, a conduit connecting said volute with the suction of the second stage impeller, re-directing conduits from the discharge of said second stage impeller and leading to the suction of a third stage impeller, a balancing chamber for said second stage impeller, and a volute discharge from said third impeller.

2. A multi-stage centrifugal pump comprising in combination, a pump casing comprising upper and lower halves, more than two impellers rotatably mounted therein, two of said impellers being opposed whereby they are balanced, a suction inlet at one end of the casing, a volute discharge from the first stage impeller, a conduit attached to the lower half of said casing and connecting said volute with the suction of the sec-

ond stage impeller, said second stage impeller having its suction opposed to the suction of the first stage impeller and positioned at the opposite end of the pump, a discharge conduit leading directly from said second stage impeller to the suction of the third stage impeller positioned intermediate the first and second stage impellers, a balancing chamber for said second stage impeller, and a final discharge from said third stage impeller.

3. A multi-stage centrifugal pump comprising in combination, a pump casing comprising upper and lower halves, more than two impellers rotatably mounted therein, two of said impellers being opposed whereby they are balanced, a suction inlet at one end of the casing, a volute discharge from the first stage impeller, a conduit attached to the lower half of said casing and connecting said volute with the suction of the second stage impeller, said second stage impeller being opposed to the first stage impeller and positioned at the opposite end of the pump, a balancing chamber for said second stage impeller, re-directing conduits from the discharge of said second stage impeller and leading to the suction of a third stage impeller, and a volute discharge from said third stage impeller.

4. A multi-stage centrifugal pump comprising in combination, a pump casing comprising upper and lower halves, more than two impellers rotatably mounted therein, two of said impellers being opposed whereby they are balanced, a suction inlet at one end of the casing, a volute discharge from the first stage impeller, a conduit connecting said volute with the suction of the second stage impeller, re-directing conduits from the discharge of said second stage impeller and leading to the suction of a third stage impeller, a volute discharge from said third impeller, and a balancing means within the casing to balance the suction pressure of the second stage impeller.

5. A multi-stage centrifugal pump comprising in combination, a pump casing comprising upper and lower halves, more than two impellers rotatably mounted therein, two of said impellers being opposed whereby they are balanced, a suction inlet at one end of the casing, a volute discharge from the first stage impeller, a conduit attached to the lower half of said casing and connecting said volute with the suction of the second stage impeller, said second stage impeller having its suction opposed to the suction of the first stage impeller and positioned at the opposite end of the pump, a discharge conduit leading directly from said second stage impeller to the suction of the third stage impeller positioned intermediate the first and second stage impellers, a final discharge from said third stage impeller, and a balancing means within the casing to balance the suction pressure of the second stage impeller.

6. A multi-stage centrifugal pump comprising in combination, a pump casing comprising upper and lower halves, more than two impellers rotatably mounted therein, two of said impellers being opposed whereby they are balanced, a suction inlet at one end of the casing, a volute discharge from the first stage impeller, a conduit attached to the lower half of said casing and connecting said volute with the suction of the second stage impeller, said second stage impeller being opposed to the first stage impeller and positioned at the opposite end of the pump, re-directing conduits from the discharge of said second stage impeller and leading to the suction of a third stage impeller, a volute discharge from said third stage impeller, and a balancing means within the casing to balance the suction pressure of the second stage impeller.

7. A multi-stage centrifugal pump comprising in combination, a pump casing comprising upper and lower halves, an odd number of impellers within said casing, two of said impellers being opposed whereby they are balanced, and the odd impeller being at the end remote from the suction inlet, conduits in said casing to convey the fluid being pumped from the impeller adjacent the suction to the impeller positioned remote therefrom, and to an intermediate impeller, and means to balance the suction pressure of the impeller at the end remote from the inlet.

8. A multi-stage centrifugal pump comprising in combination, a pump casing comprising upper and lower halves, an odd number of impellers within said casing, the suctions of the first and second stage impellers being opposed and the third stage impeller being positioned intermediate the first and second stage impellers, the third stage impeller having its suction opposed to the suction of the first stage impeller whereby said impellers are in balance, and a balancing chamber for said second stage impeller.

9. A multi-stage centrifugal pump comprising in combination, a pump casing comprising upper and lower halves, an odd number of impellers within said casing, the suctions of the first and second stage impellers being opposed and the third stage impeller being intermediate the first and second stage impellers, the third stage impeller having its suction opposed to the suction of the first stage impeller whereby said first and third stage impellers are in balance, re-directing conduits within the upper and lower halves of the casing leading from the discharge of the second stage impeller to the suction of the third stage im-

peller, and a balancing chamber for said second stage impeller.

10. A multi-stage centrifugal pump comprising in combination, a pump casing comprising upper and lower halves, an odd number of impellers within said casing, the suctions of the first and second stage impellers being opposed and at opposite ends of the casing, the third stage impeller being intermediate the first and second stage impellers, the third stage impeller having its suction opposed to the suction of the first stage impeller whereby said suctions are balanced, and a balancing chamber for said second stage impeller.

11. A multi-stage centrifugal pump comprising in combination, a pump casing comprising upper and lower halves, more than two impellers within said casing, some of said impellers being disposed in opposed relation to each other whereby they are balanced, conduits in said casing to convey the fluid being pumped from the impeller adjacent the suction inlet to the impeller positioned remote therefrom, conduits directing the fluid from said impeller remote from the intake to a third impeller intermediate the first and second stage impellers, each of said conduits and impellers maintaining a substantially constant velocity of the fluid throughout the pump, and means to balance the suction pressure of the impeller remote from said suction inlet.

In testimony whereof, I hereto affix my signature.

WILLIAM H. NOBLE.