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Kennel et al.

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[54] CENTRIFUGAL PUMP WITH OPEN TYPE IMPELLER

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[21] Appl. No.: **105,156**

[52] **U.S. Cl.**.....**415/131,** 415/213

[51] **Int. Cl.**.....**F01d 5/02,** F04d 29/02

[58] **Field of Search**.....415/129, 130, 131, 134, 139, 415/197, 200, 213

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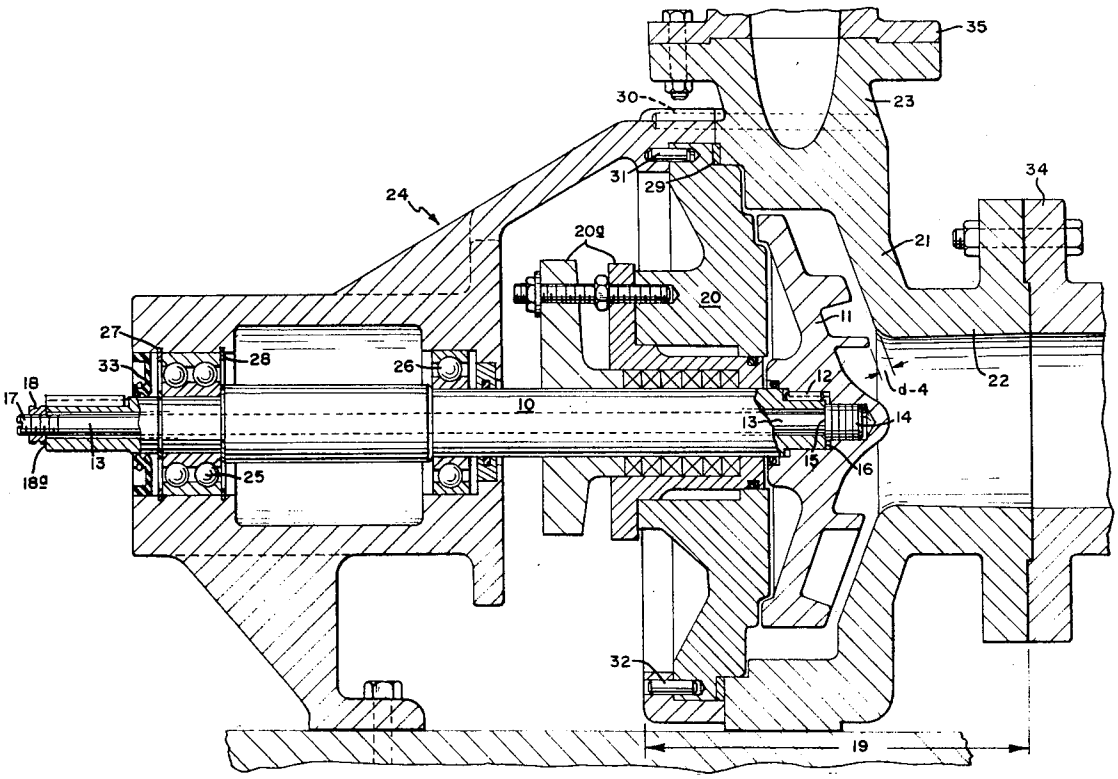
[57] **ABSTRACT**

A centrifugal pump having an open type bladed impeller, featuring an impeller shaft assembly which as such comprises a hollow impeller shaft, a tie rod within the impeller shaft, and an impeller with open blades connected to the tie rod so as to be axially adjustable relative to the shaft and thus relative to the pump housing through manipulation of the tie rod at the free end of the shaft.

14 Claims, 8 Drawing Figures



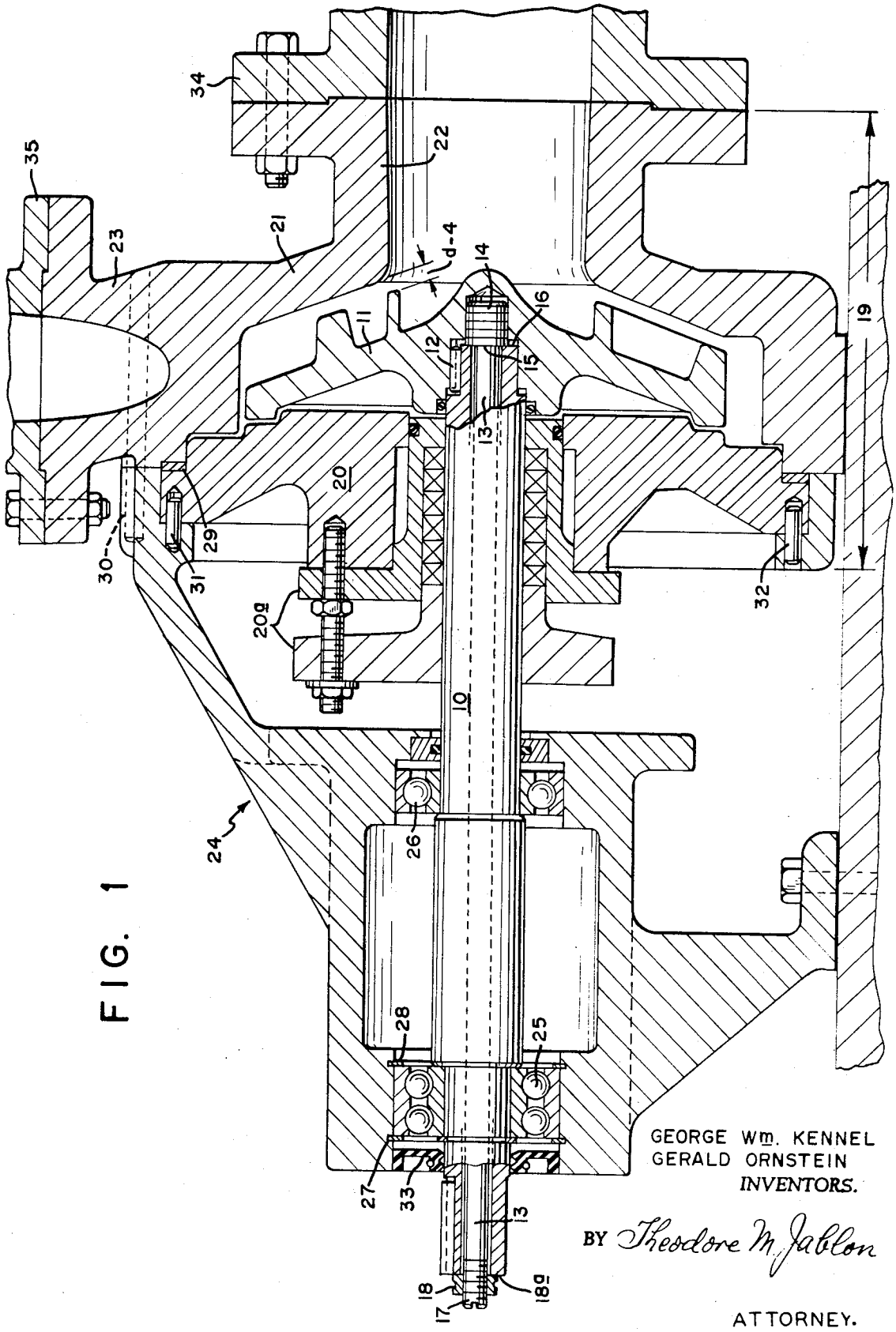


FIG. 1

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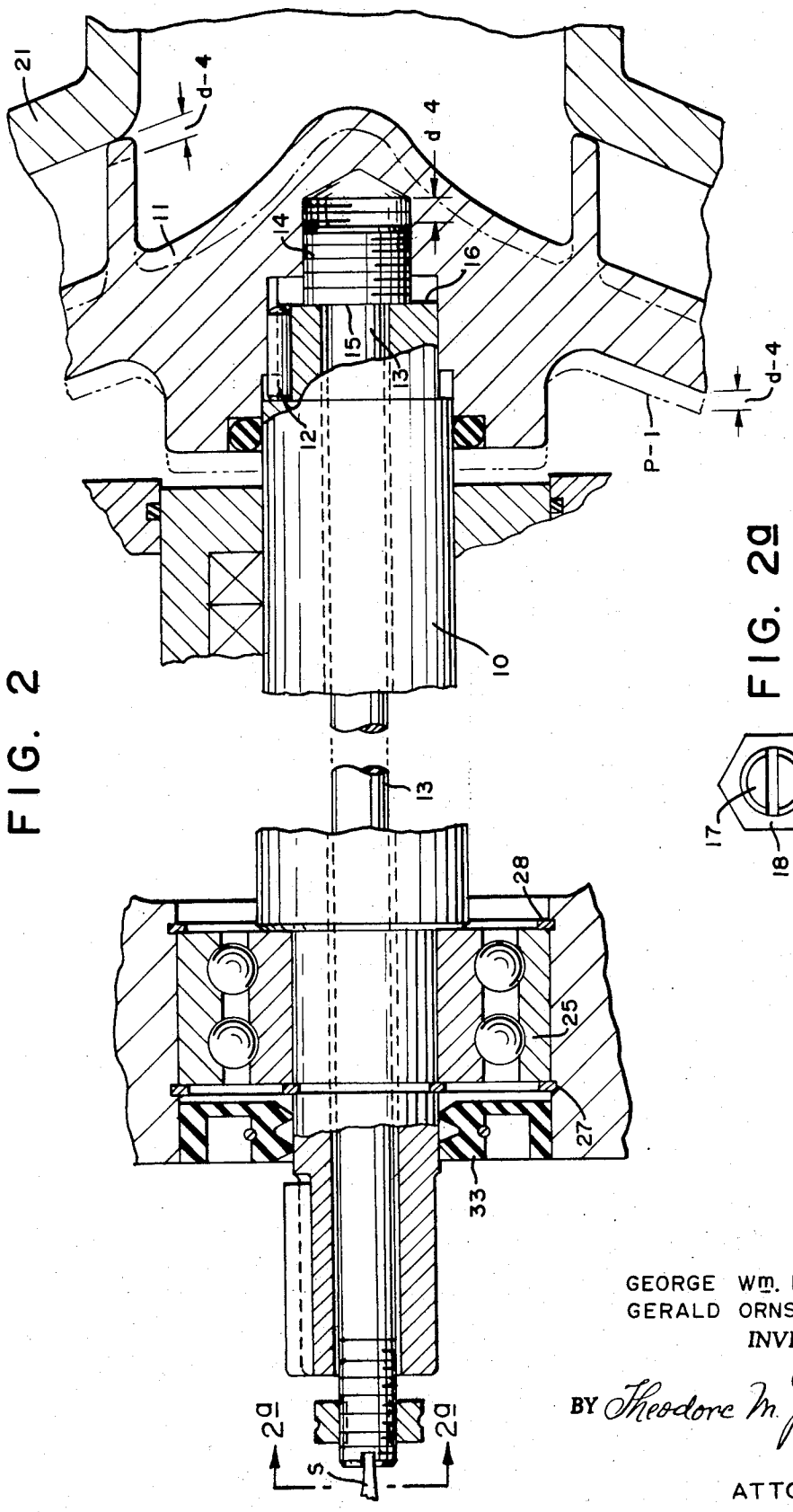

FIG. 2

FIG. 2a

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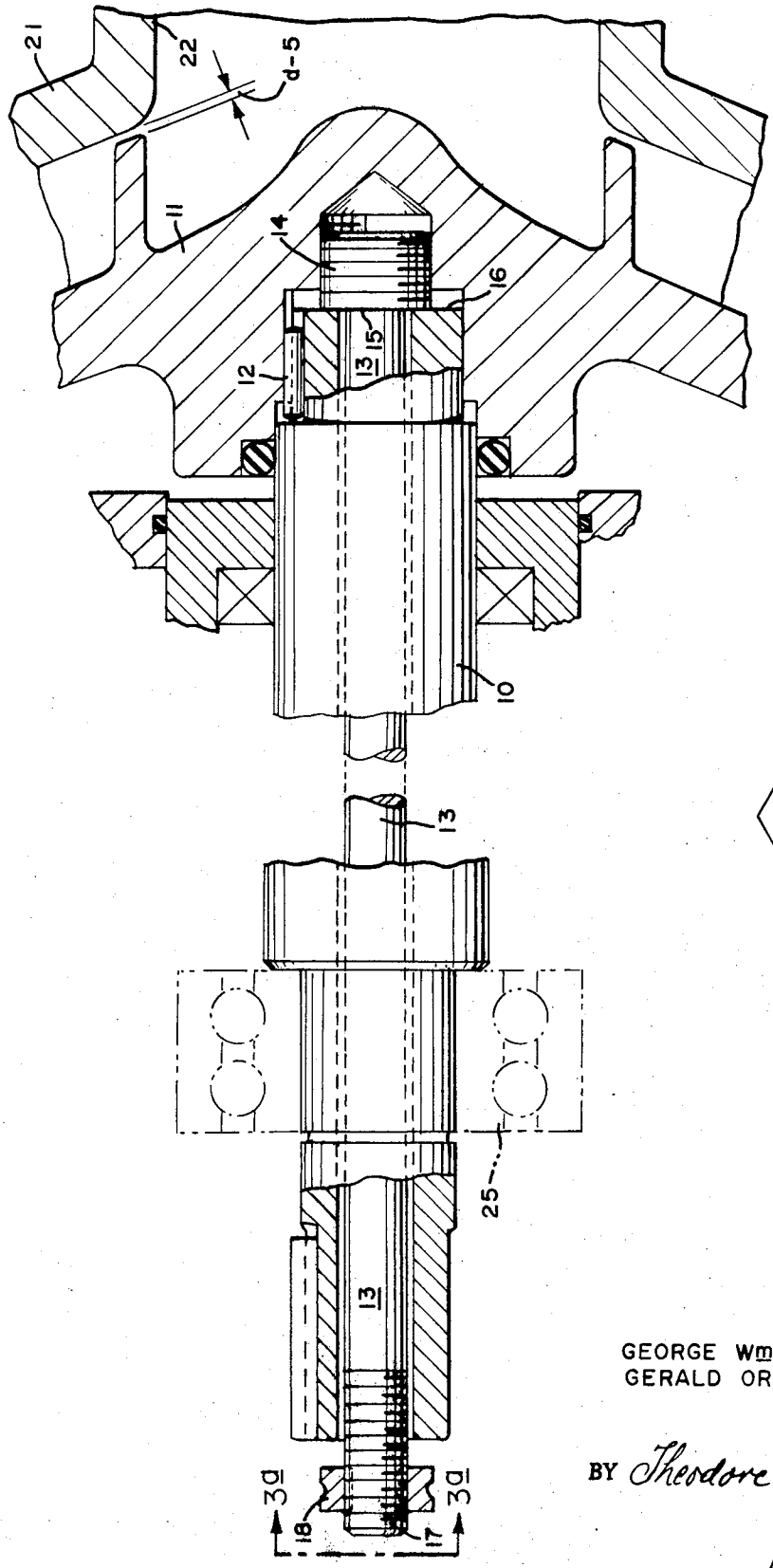

FIG. 3

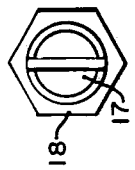

FIG. 3a

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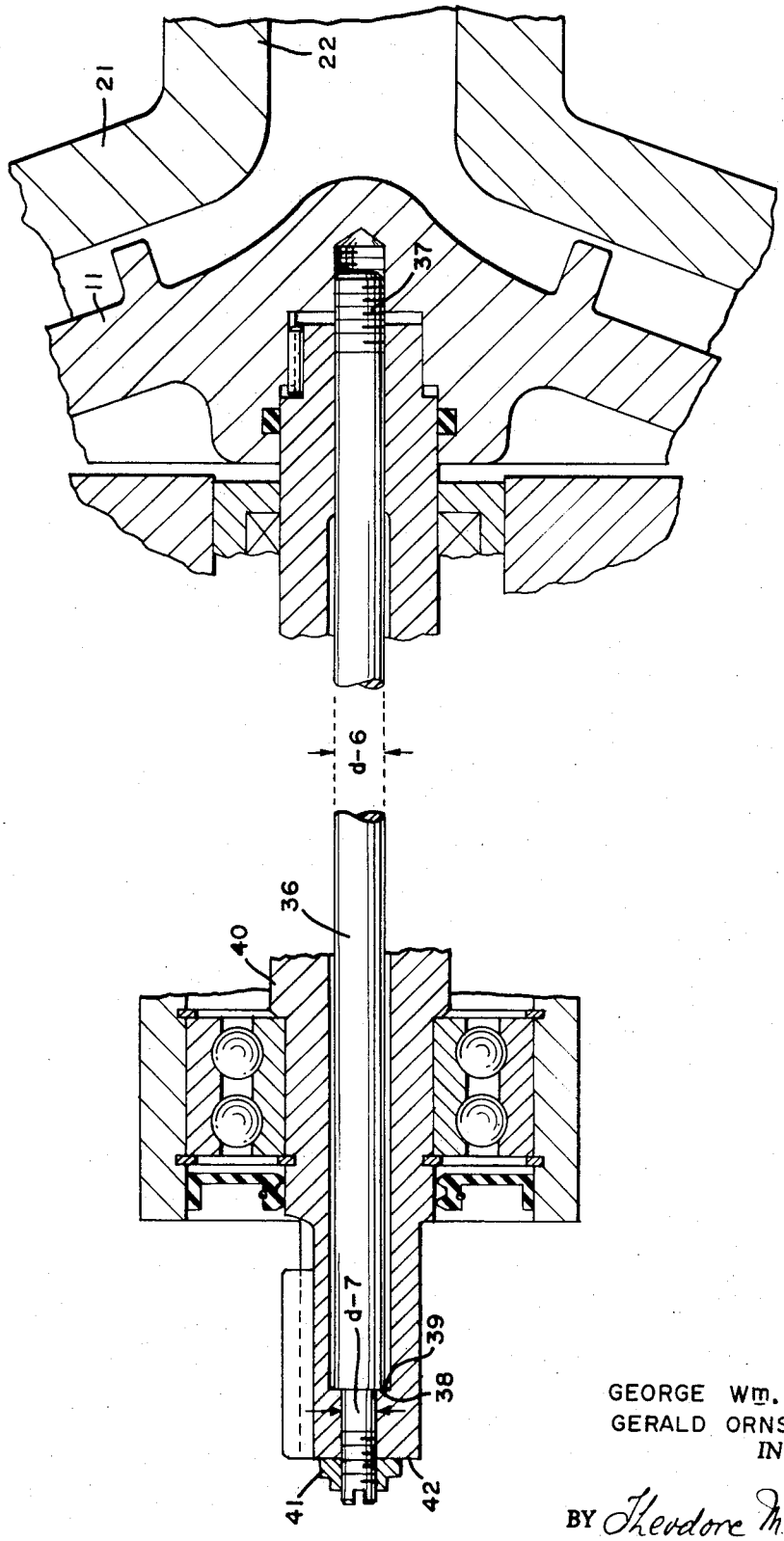
FIG. 4



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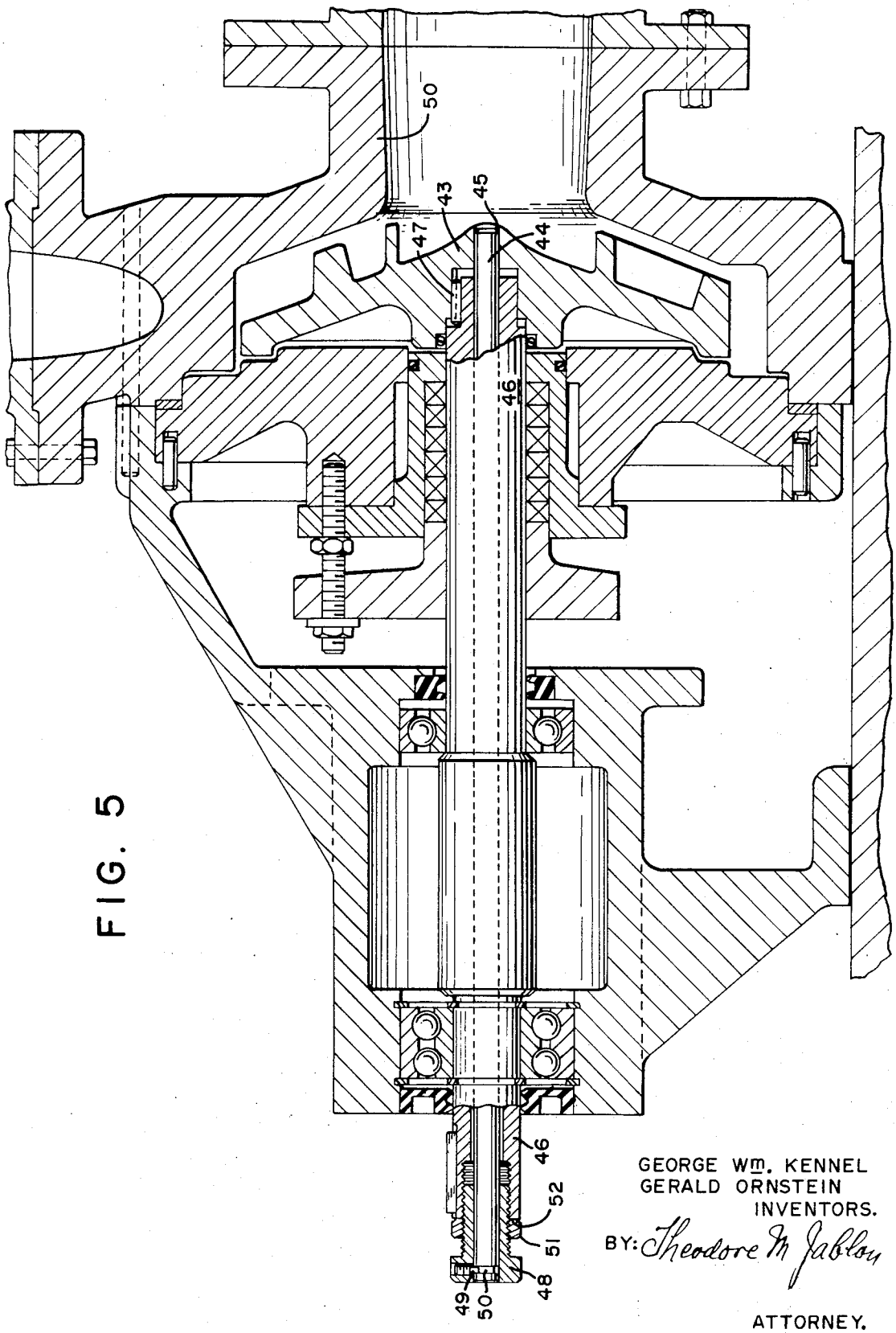

FIG. 5

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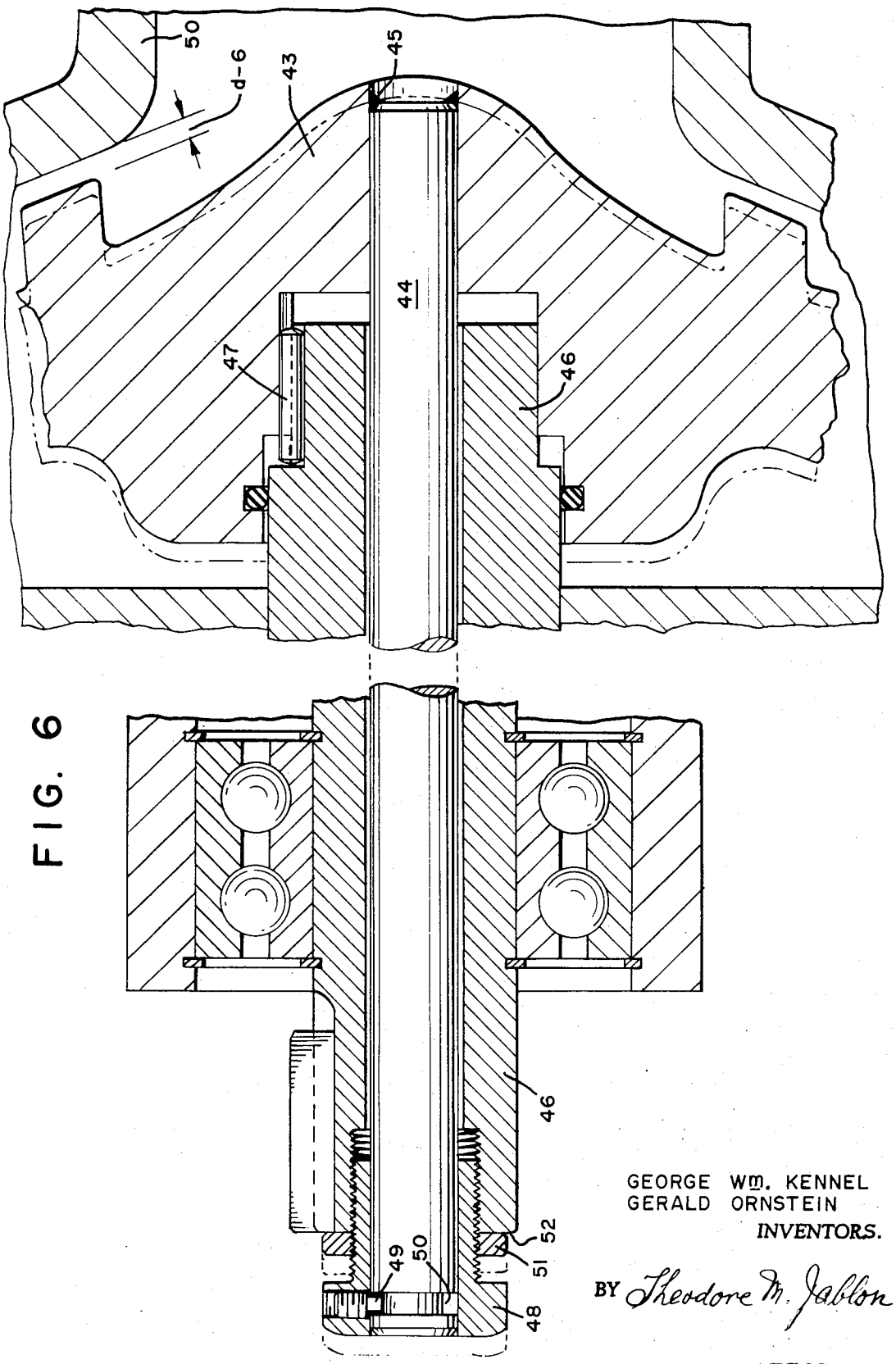

FIG. 6

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CENTRIFUGAL PUMP WITH OPEN TYPE IMPELLER

This invention relates to centrifugal pumps, and more particularly to the type having an open impeller designed for handling viscous liquids or liquids carrying solids that would tend to clog pumps of the closed impeller type.

In an open type impeller pump such as herein contemplated, the impeller comprises an impeller disc upon one side of which are formed the conventional impeller blades, while the impeller shaft extend in the opposite direction from the disc.

A housing section of the pump unit surrounds the impeller comprising a body portion or member through which extends the impeller shaft in sealed relationship therewith, and a cover portion or member connected to a pump inlet duct and a pump outlet duct.

The impeller shaft protruding from the housing section is supported by a pair of horizontally spaced bearings mounted in the bearing section of the pump which in turn is bolted to the housing section of the pump.

More in particular, this invention is concerned with devices provided in this type of pump, whereby the critical clearance between the impeller blades of the open type impeller and the pump cover member is adjustable. This impeller clearance is to be maintained at a practical minimum, in order to maintain optimum pumping efficiency. Hence, periodical check up and/or readjustment is required of the impeller clearance because of wear and tear affecting the outer free edges of the pumping blades of the pump handling the aforementioned suspensions or pulps.

Therefore, it is one object of this invention to provide improved adjusting devices of great simplicity, whereby the impeller clearance is adjustable conveniently and accurately to its optimum, while avoiding structural and manipulitive complications inherent in the adjusting means of prior art.

In a more specific sense, the object is to provide means for impeller clearance adjustment, wherein a threaded member is turnable concentric with and relative to the impeller shaft, to impart corresponding axial movement to the impeller relative to the impeller shaft, with the shaft itself secured against axial displacement relative to the pump housing.

This object is attainable in one embodiment of the invention, wherein a tie rod extends concentrically through the hollow impeller shaft. The tie rod has a forward threaded end portion screwed into the impeller which is slidably fitted upon the associated end portion of the impeller shaft, but secured against rotation relative to that shaft. Thus, because of the threaded connection, rotating the tie rod from the rear-ward end thereof, will impart corresponding axial movement to the impeller relative to the shaft which in turn is secured against axial displacement in the housing. Suitable locking means are provided, operable to fix the tie rod and the impeller in the adjusted position relative to the impeller shaft.

In another embodiment, the impeller and the tie rod are rigidly interconnected, and axially adjustable as a unit relative to the impeller shaft. The impeller clearance adjustment is effected by means of a nipple surrounding the rearward end of the tie rod, and threaded into the associated end portion of the impeller shaft. The nipple has an inward radial projection extending into a circular groove formed around the rearward end of the tie rod. Thus, turning the nipple in the thread while holding the impeller shaft against rotation, will through the rod impart axial adjustment to the impeller relative to the impeller shaft, and thus relative to the cover plate of the impeller housing.

Specific features of the invention lie in various ways of effecting the impeller clearance adjustment, and in the manner of securing the adjustment.

Other features and advantages will hereinafter appear.

As this invention may be embodied in several forms without departing from the spirit or essential characteristics thereof, the present embodiments are illustrative and not restrictive. The scope of the invention is defined by the appended claims rather than by the description preceding them, and all embodiments which fall within the meaning and range of equivalency of the claims are therefore intended to be embraced by those claims.

FIG. 1 is a longitudinal sectional view of the pump embodying one form of the invention, wherein a tie rod is threaded into the impeller, and one form of locking device secures the adjustment.

FIG. 2 is fragmentary view of the pump of FIG. 1, illustrating an intermediate phase of the procedure of the impeller adjustment.

FIG. 2*a* is an end view of FIG. 2 taken on the line 2*a*—2*a*.

FIG. 3 is a fragmentary view similar to the FIG. 2, illustrating the final phase of the impeller adjustment.

FIG. 3*a* is an end view of FIG. 3 taken on the line 3*a*—3*a*.

FIG. 4 is a fragmentary view similar to FIGS. 2 and 3, illustrating another form of the locking device.

FIG. 5 is a longitudinal sectional view of the pump, illustrating another embodiment of the invention, featuring a threaded nipple as a means for making the clearance adjustment.

FIG. 6 is an enlarged fragmentary view of the pump shown in FIG. 5, more clearly showing the adjustment means.

In the embodiment of the pump illustrated in FIGS. 1, 2, 3, the rotor assembly comprises a hollow impeller shaft **10** and an open type impeller **11** mounted for bodily axial movement upon the forward end portion of the shaft, although secured against rotation relative to the shaft as by means of a key connection **12**. Axial adjustment of the impeller on the shaft is attainable by way of a tie rod **13** extending from the impeller concentrically through the impeller shaft.

This tie rod has an enlarged head portion **14** at the forward end in threaded connection with the impeller, and formed with a rearwardly facing annular shoulder **15** engaging the adjacent end face **16** of the impeller shaft. The opposite or rearward portion **17** of tie rod **13** has threaded connection with a lock nut **18** which when tightened against the end face of the shaft will tighten the shoulder **15** against the face **16** of the shaft, thereby securing the axially adjusted position of the impeller relative to the impeller shaft, as will be furthermore described below.

The impeller is surrounded by a housing section **19** of the pump, having a body portion **20** which in turn

comprises a sealing device or stuffing box **20***a* through which extends rearwardly the impeller shaft. A complementary front cover member **21** connected to the body portion, is formed with a conventional pump inlet neck **22** and a conventional pump outlet neck **23**.

Rigidly connected to the housing section is a bearing section **24** containing a pair of horizontally spaced ball bearings **25** and **26** wherein the impeller shaft is supported for rotation. In order to secure this shaft against axial displacement relative to the bearing section, the main bearing **25** is closely confined between a pair of snap rings **27** and **28** sprung into respective grooves formed internally in the bearing section.

The pump body member **20** is confined between the front cover member **21** and the bearing section **24**, with a gasket **29** providing a seal between the two parts of the housing section. A set of bolts **30** connect the cover plate **21** with the bearing section, a pair of locating pins **31** and **32** being provided between the body member **20** and the bearing section. A sealing **33** closes the rear end of the bearing section.

For the purpose of inspecting the interior of the pump, it is only necessary to loosen the bolts **30** and to horizontally withdraw the bearing section **24** together with the body member **20** and with the rotary impeller assembly, while leaving the front cover member **21** connected to an inlet duct **34** and to an outlet duct **35**.

The manner of making the impeller clearance adjustment will now be described in connection with the embodiments in FIGS. **1** to **3** as follows:

With the impeller shaft **10** together with impeller itself secured against rotation, and lock nut **18** loosened and backed off (see FIG. **2**), the tie rod **13** may be turned as by means of a screw driver S until the impeller is advanced from the old position P–**1** shown in dot-and-dash (see FIG. **2**) to an end position wherein the impeller blades will have attained contact with the front cover member **21**. Thus, if the front end of the tie rod has a right hand thread, turning the tie rod to the left or counterclockwise will advance the impeller towards the cover plate a distance *d*–**4** which is equal to the distance that the threaded portion of the rod is retracted in the thread of the impeller. This axially induced movement of the impeller relative to the shaft takes place, since the impeller shaft itself is secured against axial displacement, and with the shoulder **15** of the tie rod remaining in contact with, or bracing itself against the forward end face **16** of the shaft **10**.

Once this forward end position of the impeller has been reached, the tie rod may be turned in the opposite right hand or clockwise direction a predetermined distance (see FIG. **3**) as measured by the pitch of the thread **14**, thereby retracting the impeller a distance representing the desired impeller clearance *d*–**5**. Lock **18** will then be tightened to secure the adjustment. Accurate impeller clearance adjustment is thus attainable without the need of disconnecting the pump from the inlet and the outlet ducts.

The embodiment in FIG. **4**, differs from FIG. **1** only in regard to the manner in which the adjustment of the impeller clearance is secured. Accordingly, a tie rod **36** has a forward threaded end portion **37** of a diameter that need be no greater than the diameter *d*–**6** of the tie rod itself. This tie rod has a reduced threaded rear end portion of the diameter *d*—**7**, thus presenting a rearwardly facing shoulder **38** tightly engaging an inwardly facing shoulder **39** formed interiorly by the impeller shaft when a lock nut **41** is tightened against the end face **42** of the impeller shaft. After loosening the lock nut, an impeller clearance adjustment may be made substantially in the manner described above in connection with FIGS. **1** to **3**.

The embodiment in FIGS. **5** and **6** differs from those in FIGS. **1** to **4** in that the impeller **43** has a fixed connection with a tie rod **44**, as indicated by a weld connection **45**. Again, the impeller is slidably fitted over the front end portion of a hollow impeller shaft **46**, with a key connection **47** securing it against rotation relative to the shaft. An externally threaded nipple **48** in threaded engagement with the internally rear end portion of the shaft, has a radial inwardly directed projection **49** engaging an annular groove **50** formed in the rear end of the rod **44**. Thus, when the impeller shaft **46** is held against rotation, turning of the nipple in the thread will, through tie rod **44** effect axial adjustment of impeller **43** relative to the shaft **46** as well as relative to front cover member **50**, as indicated by clearance *d*–**6** (see FIG. **6**). Such axial adjustment then may be secured by tightening a previously loosened lock nut **51** against the rear end face **52** of the impeller shaft.

We claim:

1. A centrifugal pump which comprises

a hollow impeller shaft,

an open type impeller mounted on the forward end portion of the shaft having torque transmitting means effective between, said shaft and said impeller while allowing for axial movement of the impeller on said shaft

a tie rod having a forward threaded end portion threaded into said impeller shaft coaxial therewith, said threaded forward end portion being formed with a rearwardly facing annular shoulder adjacent to the end face of the impeller shaft, the rearward end portion of said tie rod being formed with a thread projecting rearwardly from said shaft, said tie rod being turnable relative to the impeller shaft for thereby effecting axial adjustment of the impeller relative to said shaft, as well as relative to the cover plate of a housing section surrounding the impeller,

a lock nut provided upon said rearward end portion of the tie rod for securing the axial adjustment of the impeller due to said annular shoulder being tightened against said adjacent end face of the forward end of the impeller shaft, when said lock nut is tightened against the adjacent impeller shaft,

a housing section surrounding the impeller, having a body portion provided with sealing means for the impeller shaft extending therethrough, and having a cover portion connected to said body portion, and formed with an inlet neck and with a outlet neck,

a bearing section rigidly connected to the housing section, and having a pair of horizontally spaced bearings supporting the impeller shaft,

and means for securing the impeller shaft against axial displacement relative to said bearing section.

2. A centrifugal pump which comprises

a hollow impeller shaft formed interiorly with a forwardly facing annular shoulder,

an open type impeller mounted on the forward end portion of the shaft having torque transmitting means effective between, said shaft and said impeller while allowing for axial movement of the impeller on said shaft,

a tie rod having a forward end portion threaded into said impeller, and extending rearwardly through the impeller shaft coaxial therewith, and having a rearwardly facing annular shoulder adjacent to said forwardly facing shoulder of the impeller shaft, and also formed with a thread projecting rearwardly from said shaft, said tie rod being turnable relative to the impeller shaft for thereby axially adjusting the impeller relative to said shaft, as well as relative to the cover plate of a housing section surrounding the impeller,

a lock nut provided upon said rearward end portion of the tie rod for securing the axial adjustment of the impeller due to said rearwardly facing shoulder of the shaft being tightened against said adjacent internal shoulder of the shaft, when said lock nut is tightened against the impeller shaft,

a housing section surrounding the impeller, having a body portion provided with sealing means for the impeller shaft extending therethrough, and having a cover portion connected to said body portion, and formed with an inlet neck and with an outlet neck,

a bearing section rigidly connected to the housing section, and having a pair of horizontally spaced bearings supporting the impeller shaft,

and means for securing the impeller shaft against axial displacement relative to said bearing section.

3. A centrifugal pump which comprises

a hollow impeller shaft,

an open type impeller mounted on the forward end portion of the shaft having torque transmitting means effective between, said shaft and said impeller while allowing for axial movement of the impeller on said shaft,

a tie rod having a forward end portion fixed to said impeller, and extending rearwardly through the impeller shaft concentric therewith, and formed with an annular groove adjacent to its rearward end,

an externally threaded nipple surrounding the rearward end portion of the tie rod, and threaded into the associated rearward end portion of the impeller shaft, said nipple having an inwardly directed radial projection extending into said annular groove, so that rotating said nipple in the thread will axially adjust the tie rod bodily together with the impeller relative to the impeller shaft,

locking means for securing the nipple relative to the impeller shaft and thereby securing the axially adjusted position of the impeller,

a housing section surrounding the impeller, having a body portion provided with sealing means for the impeller shaft extending therethrough, and having a cover portion connected to said body portion, and formed with an inlet neck and with an outlet neck,

a bearing section fixedly connected to the housing section, supporting the impeller shaft,

and means for securing the impeller shaft against axial displacement relative to said bearing section.

4. The centrifugal pump according to claim 3, wherein said locking means comprise a lock nut engaging the external thread of said nipple, and effective to secure said axial adjustment of the impeller when said lock nut is tightened against the adjoining end face of the impeller shaft.

5. In a centrifugal pump of the open impeller type, a rotor assembly which comprises

a hollow impeller shaft,

an open type impeller mounted on the forward end portion of the shaft having torque transmitting means effective between, said shaft and said impeller while allowing for axial movement of the impeller on said shaft,

a tie rod having a forward threaded end portion threaded into said impeller, and extending rearwardly through the impeller shaft coaxial therewith, the threaded forward end portion being formed with a rearwardly facing shoulder adjacent to the end face of the impeller shaft, the rearward end portion of the tie rod being formed with a thread projecting rearwardly from said shaft, said tie rod being turnable relative to the impeller shaft for thereby axially adjusting the impeller relative to said shaft,

and a lock nut provided upon said rearward end portion of the tie rod for securing the axial adjustment of the impeller due to said annular shoulder being tightened against said adjacent end face of the forward end of the impeller shaft, when said lock nut is tightened against the impeller shaft.

6. In a centrifugal pump of the open impeller type, a rotor assembly which comprises

a hollow impeller shaft formed interiorly with a forwardly facing annular shoulder,

an open type impeller mounted on the forward end portion of the shaft having torque transmitting means effective between, said shaft and said impeller while allowing for axial movement of the impeller on said shaft,

a tie rod having a forward threaded end portion threaded into said impeller, and extending rearwardly through the impeller shaft coaxial therewith and formed with a rearwardly facing annular shoulder adjacent to said forwardly facing interior shoulder of the shaft, and also formed with a thread projecting rearwardly from the shaft, said tie rod being turnable relative to the impeller shaft for thereby axially adjusting the impeller relative to said shaft,

and a lock nut provided upon said rearward end portion of the tie rod for securing the axial adjustment of the impeller due to said rearwardly facing shoulder of the tie rod being tightened against said adjacent internal shoulder of the shaft, when said lock nut is tightened against the impeller shaft.

7. In a centrifugal pump, a rotor assembly which comprises

a hollow impeller shaft,

an open type impeller mounted on the forward end portion of the shaft having torque transmitting means effective between, said shaft and said impeller while allowing for axial movement of the impeller on said shaft,

a tie rod having a forward end portion fixed to said impeller, and extending rearwardly through the

impeller shaft, and formed with an annular groove adjacent to its rearward end,

an externally threaded nipple surrounding the rearward end portion of the tie rod, and threaded into the associated rearward end of the impeller shaft, said nipple having an inwardly directed radial projection extending into said annular groove, so that rotating said nipple in the thread will axially adjust the tie rod bodily together with the impeller relative to the shaft,

and locking means for securing the nipple relative to the impeller shaft and thereby securing the axially adjusted position of the impeller.

8. The centrifugal pump according to claim 7, wherein said locking means comprise a lock nut engaging the external thread of said nipple, and effective to secure said axially adjusted position of the impeller when said lock nut is tightened against the adjoining end face of the impeller shaft.

9. A centrifugal pump which comprises

a hollow impeller shaft

an open type impeller mounted on the forward end portion of the shaft having torque transmitting means effective between, said shaft and said impeller while allowing for axial movement of the impeller on said shaft,

a tie rod having a forward threaded end portion threaded into said impeller, and extending rearwardly through the impeller shaft coaxial therewith, said rod being turnable relative to the impeller shaft for thereby effecting axial adjustment of the impeller relative to said shaft, while secured against rearward axial displacement relative to said shaft,

locking means for securing said axial adjustment by fixing said tie rod relative to said shaft,

a housing section surrounding the impeller, having a body portion provided with sealing means for the impeller shaft extending therethrough, and having a cover portion connected to said body portion, and formed with an inlet neck and with an outlet neck,

a bearing section rigidly connected to the housing section, and having a pair of horizontally spaced bearings supporting the impeller shaft,

and means for securing the impeller shaft against axial displacement relative to said bearing section.

10. In a centrifugal pump of the open impeller type, a rotor assembly which comprises

a hollow impeller shaft,

an open type impeller mounted on the forward end portion of the shaft having torque transmitting means effective between, said shaft and said impeller while allowing for axial movement of the impeller on said shaft,

a tie rod having a forward end portion threaded to said impeller, and extending rearwardly through the impeller shaft concentric therewith, said rod being turnable relative to the impeller shaft for thereby effecting axial adjustment of the impeller relative to said shaft, while secured against rearward axial displacement relative to said shaft,

and locking means for securing said axial adjustment by fixing said tie rod relative to said shaft.

11. A centrifugal pump of the open impeller type, which comprises

a hollow impeller shaft,

an open type impeller mounted on the forward end portion of the shaft having torque transmitting means effective between, said shaft and said impeller while allowing for axial movement of the impeller on said shaft,

a tie rod having a forward end portion fixed to said impeller, and extending rearwardly through the impeller shaft concentric therewith, and formed with an annular groove adjacent to its rearward end,

a threaded nipple surrounding the rearward end portion of the tie rod, in threaded engagement with the associated rearward end portion of the impeller shaft, said nipple having an inwardly directed radial projection extending into said annular groove, so that rotating said nipple relative to the shaft will axially adjust the tie rod bodily together with the impeller relative to the shaft,

locking means for securing the nipple relative to the impeller shaft and thereby securing the axially adjusted position of the impeller,

a housing section surrounding the impeller, having a body portion provided with sealing means for the impeller shaft extending therethrough, and having a cover portion connected to said body portion, and formed with an inlet neck and an outlet neck,

a bearing section fixedly connected to the housing section, supporting the impeller shaft,

and means for securing the impeller shaft against axial displacement relative to said bearing section.

12. In a centrifugal pump, a rotor assembly which comprises

a hollow impeller shaft,

an open type impeller mounted on the forward end portion of the shaft having torque transmitting means effective between, said shaft and said impeller while allowing for axial movement of the impeller on said shaft,

a tie rod having a forward end portion fixed to said impeller, and extending rearwardly through the impeller shaft concentric therewith, and formed with an annular groove adjacent to its rearward end,

a threaded nipple surrounding the rearward end portion of the tie rod, in threaded engagement with the associated rearward end portion of the impeller shaft, said nipple having an inwardly directed radial projection extending into said annular groove, so that rotating said nipple relative to the shaft will axially adjust the tie rod bodily together with the impeller relative to the shaft,

and locking means for securing the nipple relative to the impeller shaft and thereby securing the axially adjusted position of the impeller.

13. A centrifugal pump which comprises

a hollow impeller shaft,

an open type impeller mounted on the forward end portion of the shaft having torque transmitting means effective between, said shaft and said impeller while allowing for axial movement of the impeller on said shaft,

a tie rod extending concentrically within said impeller shaft, and having a forward end portion connected to said impeller,

adjusting means effective between said tie rod and said impeller shaft, constructed and arranged so as to be operable for adjustably shifting said tie rod together with said impeller axially relative to said impeller shaft,

locking means for securing the axially adjusted position of the tie rod relative to the impeller shaft,

a housing section surrounding the impeller, having a body portion provided with sealing means for the impeller shaft extending therethrough, and having a cover portion connected to said body portion, and formed with an inlet neck and an outlet neck,

a bearing section fixedly connected to the housing section, supporting the impeller shaft,

and means for securing the impeller shaft against axial displacement relative to said bearing section.

14. In a centrifugal pump, a rotor assembly which comprises

a hollow impeller shaft,

an open type impeller mounted on the forward end portion of the shaft having torque transmitting means effective between, said shaft and said impeller while allowing for axial movement of the impeller on said shaft,

a tie rod extending concentrically within said impeller shaft, and having a forward end portion fixedly connected to said impeller,

adjusting means effective between said tie rod and said impeller shaft, constructed and arranged so as to be operable for adjustably shifting said tie rod together with said impeller axially relative to said impeller shaft,

and locking means for securing the axially adjusted position of the tie rod relative to the impeller shaft.

* * * * *