March 31, 1964 E. M. DETERS 3,126,831

MOTOR-PUMP UNIT

Filed Nov. 28, 1962

Fig. 1

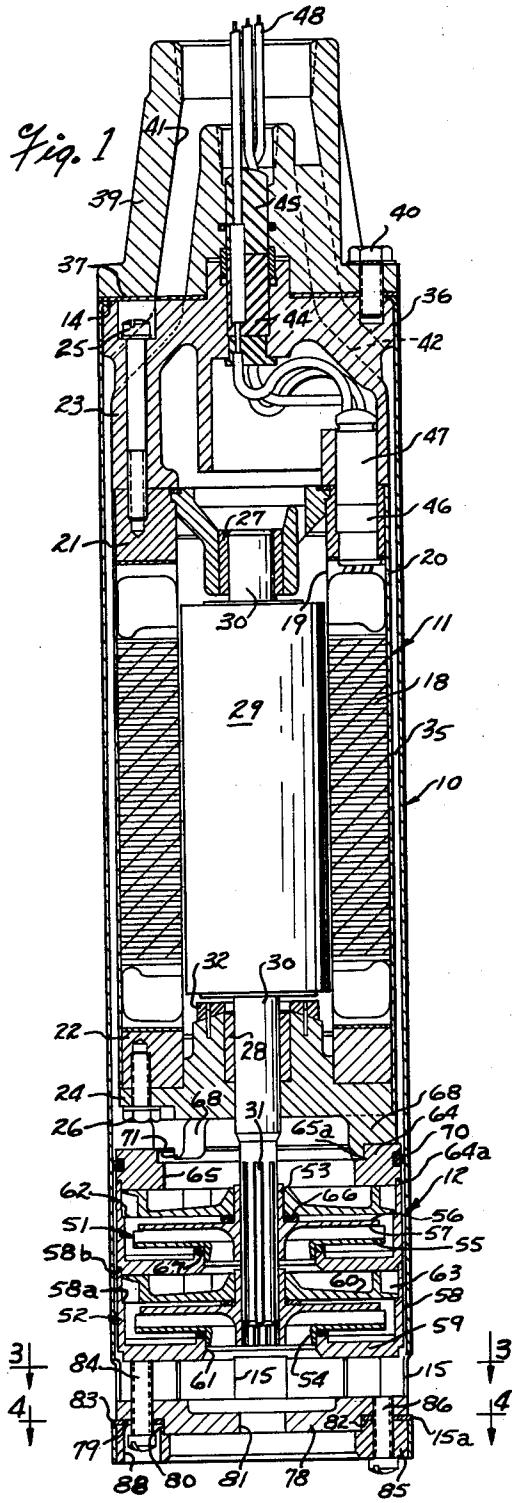


Fig. 2.

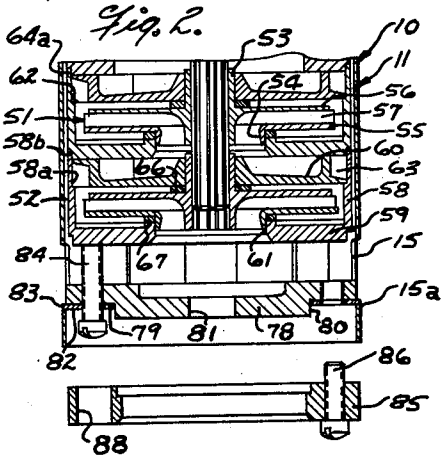


Fig. 3.

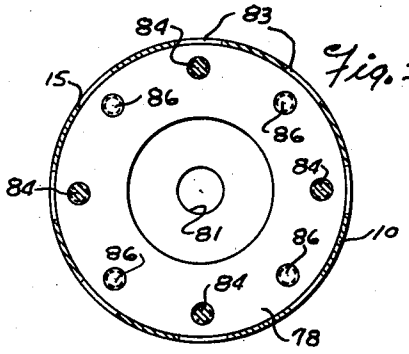
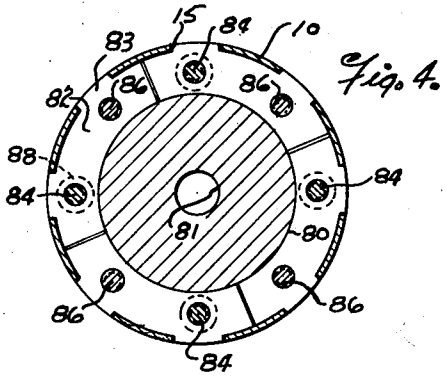


Fig. 4.



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MOTOR-PUMP UNIT

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This invention relates to pumps and particularly to submersible type motor-pump units.

In submersible motor-pump units, the outer diameter of the unit must be limited to permit reception of the motor-pump unit in a well casing or tank access opening and it is an important object of this invention to provide a submersible motor-pump unit which enables use of the maximum possible impeller and diffuser diameter for a selected overall size of the motor-pump unit to thereby permit use of a smaller number of pump stages to produce a given head at the outlet of the pump.

Another object of this invention is to provide a submersible motor-pump unit having an improved arrangement for assembling the motor and pump casing in a common outer shell and which employs the outer shell to clamp the motor and pump casing in assembled relation in the shell.

Another object of this invention is to provide a motor-pump unit in which the motor and pump casings are assembled in a common outer shell and which enables the use of an outer shell formed of relatively thin stock.

Yet another object of this invention is to provide a motor-pump unit which can be readily assembled and disassembled and which is economical to produce.

An important feature of the present invention resides in the provision of an outer tubular shell which encloses the motor and pump casings and which has circumferentially spaced inlet openings adjacent one end, and an improved clamping arrangement engageable with the inlet openings in the shell for clamping the pump casing and motor assembly in the shell.

These, together with other objects and features of the present invention will be appreciated from the following detailed description when taken in connection with the accompanying drawings wherein:

FIG. 1 is a longitudinal sectional view through the motor-pump unit, illustrating the parts in assembled relation;

FIG. 2 is a fragmentary longitudinal sectional view through the pump and illustrating the manner of assembly;

FIG. 3 is a transverse sectional view taken on the plane 3—3 of FIG. 1; and

FIG. 4 is a transverse sectional view, taken on the plane 4—4 of FIG. 1.

Referring more specifically to the accompanying drawings, the motor-pump unit includes an outer tubular shell 10, and a motor 11 and pump 12 disposed in the shell and clamped therein in assembled relation. The shell may be formed of relatively thin and light weight stock and may, for example, be formed of thin stainless steel, aluminum or the like, and has an inwardly extending abutment herein shown in the form of a peripheral flange 14 formed at one end. A plurality of circumferentially spaced inlet openings 15, herein shown eight in number, are formed in the other end of the shell 10 and spaced axially inwardly from one end thereof to provide an abutment shoulder 15*a*.

The motor 11 includes a stator 18 which is preferably of the sealed type and, as shown in FIG. 1, the stator is enclosed between thin inner and outer tubular walls 19 and 20 which extend between end ring members 21 and 22. Upper and lower end members 23 and 24 are attached to the ring members 21 and 22 respectively,

as by fasteners 25 and 26, and bearings 27 and 28 are mounted on the end members. A rotor 29 is disposed in the stator and has a shaft 30 rotatably supported in the bearings 27 and 28. An externally splined pump drive shaft 31, conveniently formed integrally with the rotor shaft 30, extends outwardly from the motor for driving the pump impellers. As shown in FIG. 1, a thrust bearing means such as 32 is provided for taking the axial loads on the rotor and shaft.

The motor 11 is arranged for axial insertion and removal from the lower end of the shell 10 and is dimensioned so as to provide a flow passage 35 between the stator and shell. The end member 23 on the upper end of the motor has a peripheral rim portion 36 which is slidable in the shell 10 and which is adapted to engage the abutment 14 at the upper end of the shell. A seal, such as a gasket 37 overlies the upper end member 23 and the flange 14 on the shell 10, and a discharge cap 39 is attached as by fasteners 40 to the end member 23 in overlying relation to the flange 14 on the shell. The discharge member 39 defines a discharge passage 41 adapted for connection to a delivery pipe (not shown), and which discharge passage communicates through passages 42 in the end member 23 with the flow passage 35 between the stator and the shell. As shown, a first pair of axially separable electrical disconnects 44 and 45 are mounted in the end member 23 and discharge member 39, and a second pair of electrical disconnects 46 and 47 are mounted in the end ring 21 and the end member 23, to enable disconnection of the motor leads 48 from the stator windings.

The pump 12 is of the multi-stage centrifugal type and includes a plurality of impellers 51, herein shown two in number, and a diffuser case 52 for each impeller. The impellers and diffuser cases for the several stages are similar and like numerals are used to designate corresponding parts. The impellers each include a hub 53 which is non-rotatably connected to the splined portion 31 of the shaft. The impellers also include outwardly extending front and rear walls 55 and 56 having impeller vanes 57 therebetween, and a central inlet opening or eye 54 is formed in the front wall of each impeller. The diffuser cases 52 each include a peripheral wall 58, a thrust wall 59 and a diffuser wall 60. As shown, the thrust wall 59 is conveniently formed integrally with the peripheral wall 58 and the diffuser wall 60 is formed separate from the peripheral wall and detachably seated in a recess 58*a* in the peripheral wall. The thrust walls 59 each have an inlet opening 61 around the eye of the respective impeller and the diffuser walls have openings 62 in the periphery thereof to transfer the fluid from the periphery of one impeller chamber to the other side of the adjacent diffuser wall. As is conventional, the diffuser walls also include vanes 63 which direct the fluid from the peripheral openings 62 to the inlet opening 61 in the thrust plate of the next succeeding stage. An outlet plate 64 having a discharge opening 65 therein is provided at the outlet of the last stage of the pump to form a central discharge opening therefor. The outlet plate 64 is loosely received in the shell 10 and has an O-ring 70 mounted in a groove in the outer periphery, which O-ring extends outwardly of the periphery of the discharge plate and engages the shell 10 to seal the interface therebetween. The hubs 53 on the impellers are conveniently radially supported in the diffuser walls and impeller thrust washers 66 and 67 are provided between the impellers and the diffuser and thrust walls respectively.

As best shown in FIG. 1, the diffuser cases are dimensioned to be loosely received in the end of the outer shell 10 and extend substantially completely thereacross to provide the maximum possible diffuser diameter. This enables the use of the maximum possible impeller diam-

eter and, as shown, the impellers extend to a point adjacent the diffuser walls and, preferably, the rear walls **56** of the impellers are spaced radially inwardly from the outer periphery of the front walls **55** so as to permit the fluid to flow axially from the impeller peripheries into the next diffuser wall.

The pump including the diffuser cases and impellers are adapted to be assembled and inserted into the end of the shell **10**. Three lugs **68** are provided on the lower end member **24** to engage and space the discharge plate **64** from the lower end member **24** and form flow passages that extend outwardly from the discharge opening **65** of the pump to the flow passage **35** between the motor and shell.

The pump must be aligned with the motor to achieve proper operation and, advantageously, the pump diffuser cases are centered on the lower end member **24** of the motor. For this purpose, the lugs **68** are provided with ears **71** that seat in a rabbet **65***a* around the discharge opening **65** in the discharge plate **64**. In manufacture, the outer faces of the ears **71** are formed concentric with the shaft opening in the lower motor end member **24**, and the tolerance between the circle defined by the outer faces of the ears **71** and the rabbet **65***a* around the discharge opening in the plate **64** are maintained sufficiently close to center the discharge plate relative to the lower motor end member. The discharge plate is also formed with a peripheral rabbet **64***a* at its underside which is dimensioned to engage the upper edge of the peripheral wall **58** of the last pump stage to center that diffuser case on the discharge plate. Similarly, the diffuser cases are formed with a peripheral rabbet **58***b* at the lower ends of the walls **58** to engage and center the upper edge of the diffuser wall of the preceding pump stage. Thus, each diffuser case is centered by engagement with the next succeeding diffuser case, or by engagement with the discharge plate. The outer peripheries of the diffuser cases are spaced from the shell **10** a distance sufficient to avoid interference by the shell to alignment of the different cases through engagement with each other and with the discharge plate. The discharge plate **64** is also preferably spaced somewhat from the shell **10** and the O-ring **70** extends outwardly beyond the periphery of the discharge plate to engage the shell and form a resilient radial support and seal between the discharge plate and the shell.

In accordance with the present invention, a clamp means is provided on the lower end of the shell **10** for pressing the pump diffuser cases, the discharge plate **64** and the motor **11** upwardly against the abutment flange **14** at the upper end of the shell to clamp the several parts together. This clamp means includes a clamp member **78** which is dimensioned slightly smaller than the inner dimension of the shell **10** to be slidable into the lower end of the shell. The clamp member has a peripheral recess in the underside thereof defining a downwardly facing shoulder **79** and an annular rim **80** spaced radially inwardly from the periphery of the clamp member. When assembled on the shell as shown in FIG. 1, the clamp member extends across the lower end of the shell adjacent the lower ends of the inlet openings **15** and is spaced from the thrust wall **59** of the lower diffuser case to provide a flow passage therebetween communicating the openings **15** with the inlet opening **61** in the lowermost diffuser case. As shown, a central opening **81** is also provided in the clamp member **78**.

The distributor member **78** is adapted to be moved to a position inwardly of the abutment shoulder **15***a* on the inlet openings **15** in the shell, as shown in FIG. 2, and arcuate shell engaging members **82** having a plurality of outwardly extending key portions **83** are adapted to be inserted into the shell with the key portions extending into the openings **15**. The shell engaging members **82** are shaped to extend around the rim portion **80** of the clamp member, when the key portions **83** extend into the openings in the shell, so that the shell engaging members are

retained in position and cannot move radially inwardly, when the clamp member is positioned as shown in FIG. 1. In the form shown, the shell engaging members are formed in four separate pieces which can be readily positioned in the shell with the key portions **83** extending into the openings **15** in the shell. It is apparent, however, that a greater or lesser number of shell engaging members could be provided and that the shell engaging member could be made in the form of a split resilient ring adapted to be radially compressed sufficient to enable insertion or removal from the inside of the shell.

A plurality of axially adjustable clamping members, herein shown in the form of four screws **84**, are mounted on the clamp member **83**. The screws **84** are retracted during assembly of the clamp member and shell engaging members **82**, are then turned in a direction to engage the thrust wall **58** on the lowermost diffuser case and press the same upwardly, to thereby clamp the diffuser cases and discharge plate **64** to the lower end of the motor and to press the motor upwardly into engagement with the abutment flange **14**. When the motor and pump unit are assembled in the shell, the clamp member **78** is spaced from the lowermost diffuser case and defines an inlet chamber therebetween which communicates the pump inlet opening **61** with the lateral openings **15** in the shell.

As shown in FIGS. 1 and 2, a shell reinforcing member, herein shown in the form of an annular ring **85** having an outer diameter substantially equal to the inner diameter of the shell, is preferably attached to the underside of the clamp member **78**, as by screws **86**, after the distributor member has been assembled in the shell. The shell reinforcing member engages the underside of the shell engaging members **82** and also engages the inner side of the shell to radially support the lower end of the shell and inhibit radial deformation of the shell when the screws **84** are tightened to clamp the motor and pump in the shell. As shown in FIGS. 1 and 4, the shell reinforcing member has four enlarged openings **88** which register with the adjusting screws **84**.

From the foregoing, it is thought that the operation and construction of the device will be readily understood. The motor including the stator, end members and rotor is assembled as a unit by insertion into the shell from the lower end and until the upper end member **23** engages the inwardly extending flange abutment **14**. The pump including the diffuser cases **52** and the impellers **51** are also assembled and inserted into the lower end of the shell with the impellers engaging the splined portion **31** of the shaft. The discharge plate **64** on the pump diffuser case engages the ears **71** on the motor to be radially located and centered thereby and the diffuser cases seat in rabbets **64***a* and **58***b* on the discharge plate and diffuser cases respectively to center the diffuser cases on the discharge plate. Thereafter, the clamp member **78** is inserted into the shell and the shell engaging members **82** are moved into the shell and then outwardly to have the key portions **83** project into the openings **15**, after which the clamp member is moved downwardly to the position shown in FIG. 1 to retain the arcuate shell engaging members in position. Thereafter, the screws **84** are tightened to clamp the diffuser cases, discharge plate and motor in assembled relation within the shell. The shell reinforcing member **86** is inserted into the shell and secured to the underside of the clamp member after the clamp member is assembled in the shell, and preferably before the screws **84** is tightened, to inhibit deformation of the lower end of the shell.

The above arrangement eliminates the customary tie rods or bolts for clamping the pump to the motor and allows the use of the maximum diameter diffuser and impellers. The inlet openings **15** in the shell provide a relatively large bearing area for engagement by the key portions **83** on the shell engaging members **82**, and this enables the use of relatively thin walled shell members, if desired. Moreover, this arrangement facilitates as-

sembly of the motor and pump since it is unnecessary to align the screws 84 with tapped openings as is required when tie bolts are used.

I claim:

1. A submersible motor-pump unit comprising a one-piece tubular shell defining an enclosure for the motor and pump, a motor including a stator assembly in said shell dimensioned for axial insertion and removal therefrom and defining a flow passage between the stator and shell, a rotor in said stator and a shaft on said rotor, a pump including a pump casing in said shell dimensioned for axial insertion and removal therefrom and engageable with one end of the stator assembly, said casing having an inlet adjacent one end of the shell and an outlet communication with said flow passage between the shell and stator, impeller means on the rotor shaft for pumping liquid from said inlet to said pump outlet, means engaging the stator assembly for anchoring the stator assembly against movement out of the shell, said shell having a plurality of circumferentially spaced inlet openings therein spaced axially from one end of the shell, a clamp member in said one end of said shell dimensioned for axial insertion and withdrawal therefrom and defining an inlet chamber in the shell at one end of the pump casing communicating the pump inlet with said inlet openings in the shell, key means engageable with said clamp member and extending into said inlet openings in said shell to limit movement of said clamp member out of said shell, and clamp means on said clamp member adjustable axially of said shell for pressing said pump casing against the stator assembly.

2. A submersible motor-pump unit comprising, an outer tubular shell defining an enclosure for the motor and pump, a motor including a stator assembly in said shell dimensioned for axial insertion and withdrawal therefrom and defining a flow passage between the shell and motor, a rotor in said stator and a shaft on said rotor, a pump including a pump casing in said shell dimensioned for axial insertion and removal therefrom and engageable with one end of the stator assembly, said casing having an inlet adjacent one end of the shell and an outlet communicating with said flow passage between the shell and stator, impeller means on the rotor shaft for pumping liquid from said inlet to said pump outlet, means engageable with the stator assembly for anchoring the stator assembly against movement out of the shell, said shell having a plurality of circumferentially spaced openings therein spaced axially from one end of the shell, a clamp member in said one end of the shell and dimensioned for axial insertion and removal therefrom, at least one arcuate shell engaging member disposed inside said one end of the shell and underlying the periphery of said clamp member and having a plurality of outwardly extending key portions extending into the openings in the shell to limit movement of the clamp member out of the shell, and means on said clamp member engageable with said pump casing for pressing the pump casing against the stator assembly.

3. A submersible motor-pump unit comprising, an outer tubular shell defining an enclosure for the motor and pump, a motor including a stator assembly in said shell and defining a flow passage therebetween, a rotor in said stator and a shaft on said rotor, a pump including a pump casing in said shell and engageable with one end of the stator assembly, said casing having an inlet adjacent one end of the shell and an outlet communicating with said flow passage between the shell and stator, impeller means on the rotor shaft for pumping liquid from said inlet to said pump outlet, means engageable with the stator assembly for anchoring the stator assembly to the shell, said shell having a plurality of circumferentially spaced openings therein spaced axially from one end of the shell, a clamp member in said one end of the shell and extending around the inside thereof, said stator assembly and pump casing and clamp member being dimensioned for axial insertion and removal from the shell, at least one arcuate shell engaging member disposed inside said one end of the shell and underlying the periphery of said clamp member and having a plurality of outwardly extending key portions extending into the openings in the shell to limit movement of the clamp member out of the shell, means on said clamp member engageable with said pump casing for pressing the pump casing against the stator assembly, and means on said clamp member for limiting inward movement of said shell engaging member when the shell engaging member underlies the periphery of the clamp member to prevent disengagement of the key portions from the shell opening.

4. A submersible motor-pump unit comprising a one-piece outer tubular shell having an inwardly extending abutment adjacent one end, a motor in said shell dimensioned for axial insertion and removal from the other end of the shell and including a stator having first and second end members at opposite ends thereof, and a rotor in the stator having a shaft and bearing means rotatably supporting said shaft, a pump including a pump casing in said shell dimensioned for axial insertion and removal from said other end and having a pump inlet adjacent said other end of the shell and a pump outlet at the end adjacent said second end member of said stator, said stator being spaced from said shell to define an outlet flow passage therebetween communicating with the pump outlet, said shell having a plurality of circumferentially spaced inlet openings spaced axially from said other end of the shell, a distributor member slidable into said other end of the shell and defining an inlet chamber in said shell communicating said pump inlet with said inlet openings in the shell, key means engageable with said distributor member and extending into said inlet openings in said shell to limit movement of said distributor member out of the shell, and means on said distributor member adjustable axially of said shell for pressing said pump casing against the stator and for pressing said stator against said inwardly extending abutment to clamp said pump casing and stator in the shell.

5. The combination of claim 4 wherein said pump casing has an outer diameter sufficiently smaller than the inner dimension of the shell to permit limited radial shifting of the casing in the shell, said pump casing and said second end member having interengaging means thereon for radially centering said second end member and said pump casing.

6. The combination of claim 5 wherein said pump casing includes a plurality of axially separable diffuser cases having interengaging key portions for radially aligning the several diffuser cases.

7. A submersible motor-pump unit comprising an outer tubular shell having an inwardly extending abutment adjacent one end, a motor in said shell dimensioned for axial insertion and removal from the other end of the shell and including a stator having first and second end members at opposite ends thereof, and a rotor in the stator having a shaft and bearing means rotatably supporting said shaft, a pump including a pump casing in said shell dimensioned for axial insertion and removal from said other end of the shell and having a pump inlet adjacent said other end of the shell and a pump outlet at the end adjacent said second end member of said stator, said stator being spaced from said shell to define an outlet flow passage therebetween communicating with the pump outlet, said shell having a plurality of circumferentially spaced inlet openings spaced axially from said other end of the shell, a distributor member slidable into said other end of said shell and defining an inlet chamber in said shell communicating said pump inlet with said inlet openings in said shell, a plurality of arcuate shell engaging members underlying the periphery of said distributor member and each having at least one outwardly extending key portion extending into the openings in the shell, and means on said distributor member adjustable

in a direction axially of said shell for clamping the pump casing and the motor against said abutment on the shell.

8. The combination of claim 7 wherein said distributor member has a peripheral flange portion and a rim portion spaced radially inwardly from the periphery of the flange portion, said shell engaging members extending around said rim portion and underlying said flange portion.

9. A submersible pump comprising an outer tubular shell, a pump including a pump casing in said shell dimensioned for axial insertion and removal therefrom and having a pump inlet adjacent one end and a pump outlet adjacent the other end, said casing including a plurality of axially separable sections, pump impeller means for pumping liquid from said pump inlet to said pump outlet, said shell having a plurality of circumferentially spaced inlet openings spaced axially from one end, a distributor member slidable into said one end of said shell and defining an inlet chamber communicating said pump inlet with said inlet openings in said shell, a plurality of arcuate shell engaging members underlying the periphery of said distributor member and each having at least one key portion extending outwardly into the openings in the shell to limit movement of said distributor member out of the shell, means on the distributor member adjustable in a direction axially of the shell for pressing the pump casing in one direction, and means engageable with the other end of the pump casing for limiting movement of the other end of the casing.

10. A submersible pump comprising an outer tubular shell, a pump including a pump casing in said shell having a pump inlet adjacent one end and a pump outlet adjacent the other end, said casing including a plurality of axially separable diffuser cases dimensioned for axial insertion and removal from the shell, pump impeller means

for pumping liquid from said pump inlet to said pump outlet, said shell having a plurality of circumferentially spaced inlet openings spaced axially from one end, a distributor member slidable into said one end of said shell and defining an inlet chamber communicating said pump inlet with said inlet openings in said shell, a plurality of crescent shaped shell engaging members underlying the periphery of said distributor member and each having a plurality of key portions extending outwardly into said openings in the shell to limit movement of the distributor body out of the shell, abutment means engageable with the outlet end of the casing, and means on the distributor member adjustable in a direction axially of the shell for pressing the pump casing against said abutment means.

11. The combination of claim 10 wherein said distributor member has a peripheral flange portion and a rim portion spaced radially inwardly from the periphery of the flange portion, said shell engaging members extending around said rim portion and underlying said flange portion.

12. The combination of claim 10 including a shell reinforcing member having an outer diameter substantially equal to the inner diameter of the shell, said reinforcing member underlying the distributor member and engaging the lower end of the shell, and means attaching the reinforcing member to the distributor member.

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