Sept. 16, 1969 H. G. ALLEN 3,467,015

HYDRAULIC PUMP-MOTOR COMBINATION

Filed March 28, 1968 3 Sheets-Sheet 1

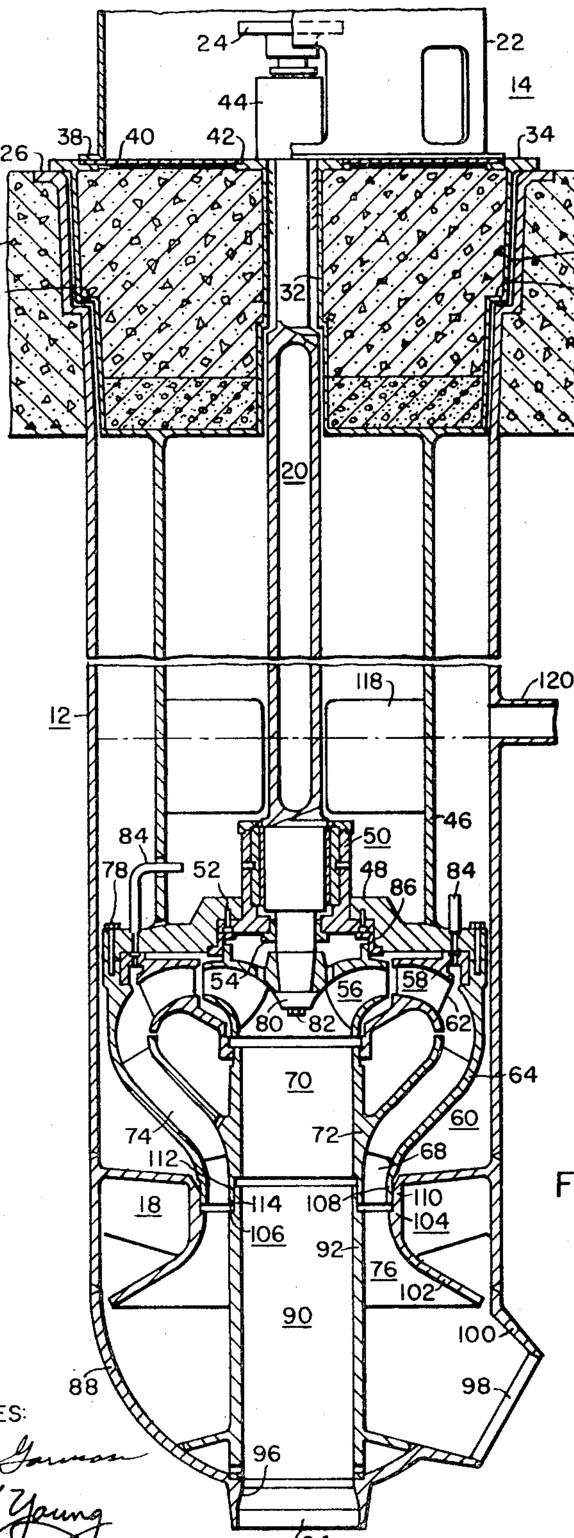

FIG. 1.

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HYDRAULIC PUMP-MOTOR COMBINATION

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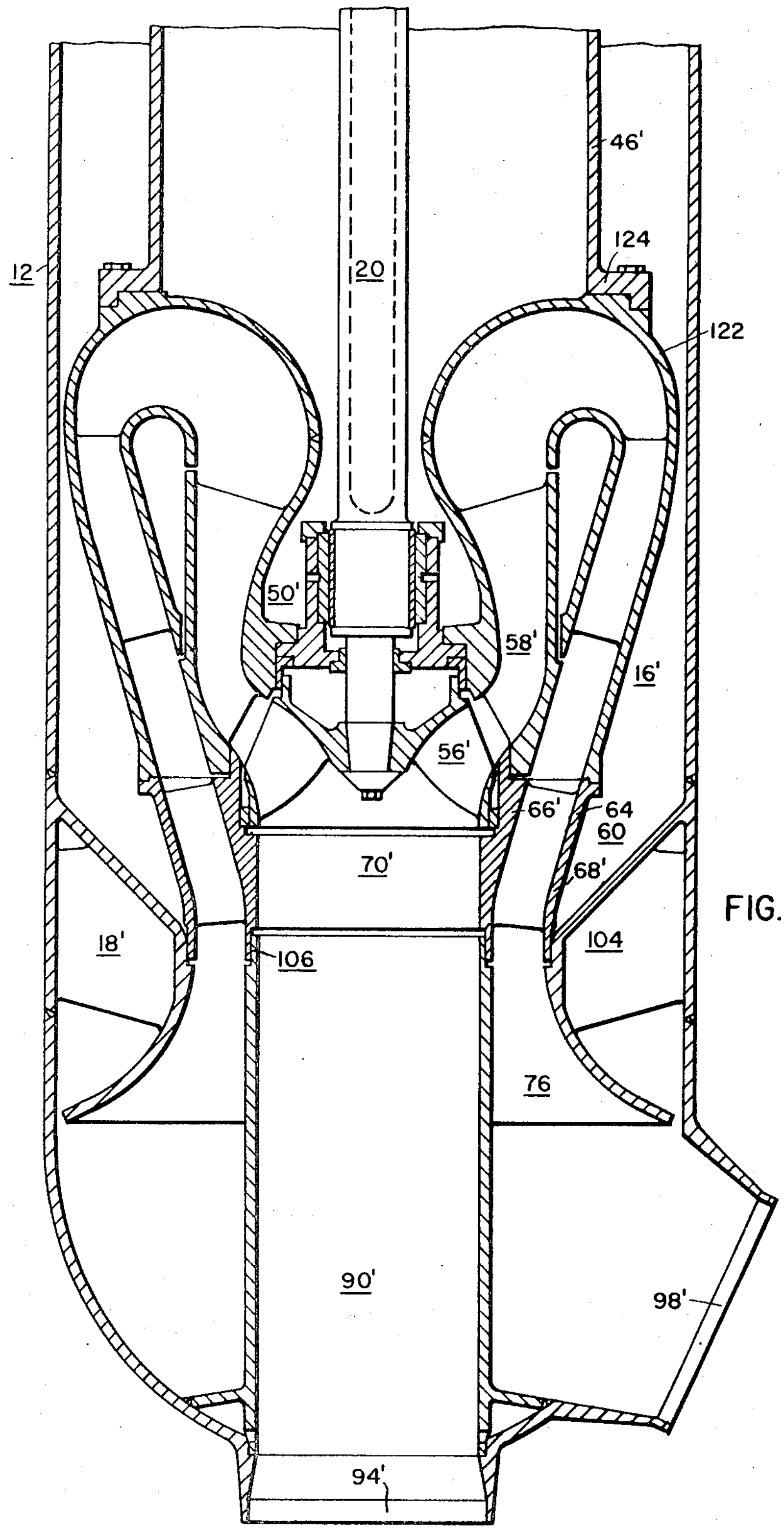

FIG. 2.

HYDRAULIC PUMP-MOTOR COMBINATION

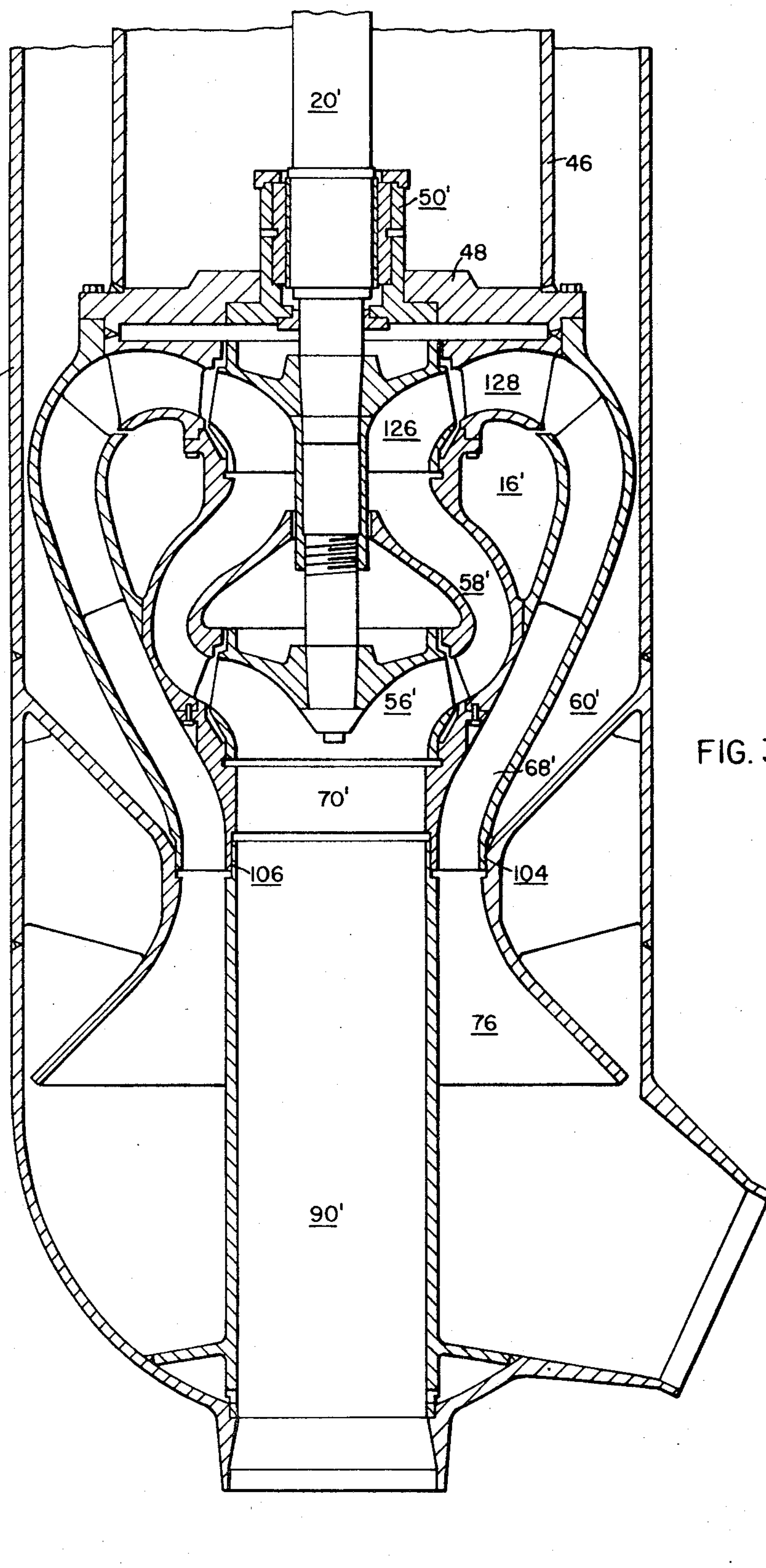

FIG. 3.

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HYDRAULIC PUMP-MOTOR COMBINATION

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U.S. Cl. 103—87 12 Claims

ABSTRACT OF THE DISCLOSURE

A pump-motor combination is assembled to a vertical cylindrical tank suspended from a plant deck and the like. The motor is mounted on a flange at the upper end of the tank at floor level and the hydraulic pump component is hung vertically from the motor support within the tank. The tank carries a pool of liquid metal which submerges the hydraulic elements of the pump. The suction and discharge pipe connections are at the lower end of the tank. Inert gas fills the space between the liquid level and the deck shielding. The pump component is removable from the tank as a unit.

BACKGROUND OF THE INVENTION

This invention relates, generally, to hydraulic pumps and, more particularly, to large capacity centrifugal pumps for handling liquid metal at high temperatures.

The building of large pumps for liquid metal systems is a relatively new business. In pump structures produced up to this time, a major consideration was the best arrangement of the suction and discharge flow to and from the pump and also to have suitable pump disconnect joints. A satisfactory arrangement of these joints was made difficult because of the thermal expansion and contraction of the connecting column and shafting between the pump and the motor. In prior structures, an attempted solution of this problem has been to provide only one joint at the discharge connection, thereby requiring that the pump take suction directly from the tank sump. However, this arrangement creates other difficulties, such as:

(1) Fluid turbulence within the sump, making it more difficult to maintain a stable gas to liquid interface.

(2) Carrying flow through the sump introduces hydraulic losses with detrimental effect on the net positive suction head (NPSH).

(3) This arrangement places the sump at pump suction pressure, the lowest pressure point within the pumping system, which creates a difficult liquid level control problem.

An object of this invention is to provide a centrifugal pump structure which overcomes the foregoing difficulties.

Other objects of the invention will be explained fully hereinafter or will be apparent to those skilled in the art.

SUMMARY OF THE INVENTION

In accordance with one embodiment of the invention, a hydraulic pump-motor combination is assembled to a vertical cylindrical tank suspended from a supporting structure, such as a plant deck and the like. The motor support is mounted at the upper end of the tank at floor level; and the pump component extends downwardly from the motor support within the tank. The hydraulic component structure comprises two basic parts, a centrifugal pump unit suspended from the motor support, and a suction and discharge header which forms the bottom of the tank. A pool of liquid metal in the tank submerges the hydraulic elements of the pump. Suction and discharge pipe connections are at the lower end of the tank. Inert gas fills the space between the liquid metal and the deck shielding. Slip joints connecting the pump unit and the suction and discharge header provide for removal of the complete pump unit for maintenance. The joints are free to move axially permitting axial movement, caused by temperature transients, between the pump and the tank.

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BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the nature and objects of the invention, reference may be had to the following detailed description, taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a view, in vertical section, of a centrifugal pump-motor combination embodying princpal features of the invention; and

FIGS. 2 and 3 are views, in vertical section, of two different hydraulic components suitable for use in the pump-motor combination.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to the drawings, and particularly to FIG. 1, the hydraulic pump-motor combination shown therein comprises a supporting structure **10**, a generally cylindrical tank **12**, a motor support **14**, a centrifugal pump **16**, a suction and discharge header **18** which forms the bottom of the tank **12**, and a pump shaft **20** which extends vertically through the motor support **14**. Only a portion of a base **22** for the motor which drives the pump **16** through the shaft **20** is shown in the present drawing. The driving motor may be of any suitable type having a vertical shaft which is connected to the shaft **20** by means of a coupling **24** only a portion of which is shown.

In the present drawing, the supporting structure **10** is illustrated as a concrete deck. The supporting structure may be the floor of a building or it may be a structural steel framework capable of supporting the pump-motor combination. As shown, the tank **12** has an outwardly extending flange **26** and a shoulder **28** which rests on the concrete of the deck shielding **10**, thereby suspending the tank from the supporting structure.

A plug comprising a metal container **30**, which is of a cake pan shape having a tubular sleeve **32** extending vertically through the central portion of the container, is mounted at the top of the supporting structure **10** by means of a flange **34** and a shoulder **36** on the container. The flange **34** rests on the flange **26** of the tank and the shoulder **36** may rest on the shoulder **28** of the tank **12**. The container **30** may be filled with concrete or other suitable material.

The motor base **22** has a flange **38** which rests on a cover plate **40** which, in turn, rests on the flange **34** at the outer rim of the container **30** and a flange **42** on the tubular sleeve **32** of the container **30**. A seal **44**, which may be of any suitable type, surrounds the shaft **20** and is mounted on the flange **42**.

The pump component **16** is suspended from the motor support **14** by means of a cylindrical sleeve **46** which may be formed integrally with or secured to the bottom of the container **30** by welding or other suitable means. A pump supporting ring **48** is secured to the lower end of the sleeve **46** as by welding. A radial bearing assembly **50** is provided for the pump shaft **20**. The bearing assembly **50** may be of any suitable type and it is attached to the ring **48** by bolts **52**. A seal **54** is provided for the shaft **20** where it extends from the bearing assembly **50**.

The pump **16** comprises an impeller **56**, a diffuser **58** and a casing **60**. The impeller **56** shown in FIG. 1 is of a single suction, radial flow, Francis blade type. The diffuser **58** contains a plurality of vanes **62** which provide efficient conversion of velocity energy to pressure energy.

The pump casing **60** comprises two spaced open bottom concentric bowls **64** and **66** having a discharge flow passage **68** between the concentric bowls. The inner bowl **66** has a generally cylindrical suction approach **70** therein with a wall **72** formed integrally with the bowl **66**. The casing discharge passage **68** has vanes **74** therein which remove the fluid radial velocity received from the diffuser **58** and direct the flow into a discharge cone **76** described hereinafter.

The casing **60** and the diffuser **58** are clamped to the supporting ring **58** by bolts **78**. The impeller **56** is attached to the shaft **20** by an impeller nut **80** and a bolt **82**. As previously explained, the ring supports the radial bearing assembly **50** for the shaft **20**. If the bearing assembly **50** is of a hydrostatic type it may be connected to the pump **16** by means of pipes **84** to supply liquid under pressure to the bearing assembly **50**. A seal **86** is provided between the impeller **56** and the ring **48**.

The suction and discharge header assembly **18** controls the flow transition between the pumping element and the piping of the circulatory system in which the pump is connected. The assembly **18** comprises a header **88**, a generally cylindrical suction adapter **90** having a vertically disposed wall **92**, and the discharge cone **76** which surrounds and is spaced from the adapter **90**. The assembly **18** is preferably a welded structure and can be formed from steel plate.

The header **88** has an inlet opening **94** with a vertically extending wall **96** substantially in alignment with the vertical wall **92** of the suction adapter **90**. The header **88** also has a discharge opening **98** with an angularly extending wall **100** substantially in alignment with the angular or flared wall **102** of the discharge cone **76**. As previously explained, the openings **94** and **98** may be connected to the circulatory system piping.

In order that the entire pump component may be removed from the tank as a unit, and to permit axial movement between the pump and the tank caused by temperature transients, slip joints **104** and **106** are provided to connect the pump casing **60** with the suction and header assembly **18**. These joints must seal against pump differential pressure. The joint **104** is formed between a machined portion **108** of the lower end of the wall of the outer casing bowl **64** and a machined portion **110** of the wall of the discharge cone **76**. The joint **106** is formed between a machined portion **112** of the wall **72** of the inner bowl **66** and a machined portion **114** of the wall **92** of the suction adapter **90**. The joints **104** and **106** are of a relatively small diameter and the concentric arrangement allows machining the joints to a relatively close tolerance. The result is less fluid leakage, and thus, higher pumping efficiency.

As previously stated, the slip joints are free to move axially to permit axial movement between the pump and the tank. The joints permit the entire pump assembly, the pump shaft and the motor support to be removed from the tank as a unit for maintenance. The concentric joint favors a lower net positive suction head (NPSH) because the structure permits arrangement of a straight suction approach to the impeller eye.

The present pump structure is suitable for handling a liquid metal, such as sodium, at a relatively high temperature. The tank **12** contains a pool of the liquid metal which completely submerges the hydraulic elements of the pump. In order to prevent the atmosphere from combining with the sodium, an inert gas, such as argon, fills the space between the liquid metal level and the deck shielding **10**.

As previously explained, the pump flow is ducted to and from the suction and discharge header **18** so that this flow is kept separate from the liquid in the sump of the tank **12**. This prevents fluid disturbance in the sump and reduces intermixing gas with the liquid metal at the gas-liquid interface. Stagnating vanes **118** are mounted on the sleeve **46** to prevent swirling of the sodium at the liquid interface.

Another feature of the hydraulic component is that the net internal leakage is directed from the pump element into the sump. This simplifies the control of the sump liquid level. The leakage can be transferred back to the circulatory system by connecting an overflow pipe to an overflow outlet **120** and connecting the overflow pipe into the circulatory system. A properly constructed overflow pipe would establish a minimum liquid level at the inlet to the overflow pipe.

The hydraulic component **16'** shown in FIG. 2 is of a high specific speed type which provides a relatively large flow of liquid at a relatively low head as compared with the hydraulic component shown in FIG. 1. The impeller **56'** and the diffuser **58'** are of the axial flow type. The pump assembly is supported by bolting an extension **122** of the pump casing **60'** to a flange **124** on the lower end of the sleeve **46'**. The radial bearing assembly **50'** is also supported by the pump casing **60'**. The concentric bowls **64'** and **66'** and the discharge passage **68'** are also of the axial flow type. The suction and discharge openings are of a large diameter compared with the size of the impeller. Otherwise, the pump structure and the suction and discharge header **18'** are similar to the structure hereinbefore described. The slip joints **104** and **106** permit the entire pump assembly to be removed from the tank **12** in the manner hereinbefore described.

The pump component **16'** shown in FIG. 3 is of a two stage type which is capable of producing a greater pressure head at a lower speed as compared with the pump component shown in FIG. 1. As shown, a second impeller **126** is secured to the shaft **20'** above the first impeller **56'**. The diffuser **58'** is disposed between the first impeller **56'** and the second impeller **126**. A second diffuser **128** is disposed between the impeller **126** and the discharge passage **68'** of the casing **60'**. The pump assembly is supported by the ring **48** which is attached to the sleeve **46** as hereinbefore described. The bearing assembly **50** for the shaft **20'** is supported by the ring **48** as previously described. The slip joints **104** and **106** function in the manner hereinbefore described. Thus, the pump structures shown in FIGS. 2 and 3 fit into the same overall pump-motor concept arrangement described in connection with FIG. 1. These arrangements have the unique features hereinbefore described.

From the foregoing description it is apparent that the invention provide a pump-motor combination which is particularly suitable for handling a large quantity of liquid metal at a relatively high temperature. The hydraulic component provides adequate hydraulic efficiency and net positive suction head performance. The pump arrangement maintain a stable gas to liquid metal interface. Piping connections are made directly to the tank containing the pump component. Provision is made for thermal expansion between the pump component and the tank without affecting the external piping connections. Also, the arrangement of the suction and discharge connections between the pump and the tank are such that hydraulic losses are reduced.

Since numerous changes may be made in the above-described structures and different embodiments of the invention may be made without departing from the spirit and scope thereof, it is intended that all subject matter contained in the foregoing description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

I claim as my invention:

1. In a pump-motor combination, a supporting structure, a vertical generally cylindrical tank suspended from said structure, a motor support at the top of the tank, a centrifugal pump casing suspended from the motor support within the tank, a suction and discharge header forming the bottom of the tank, a pump shaft extending vertically through the motor support, an impeller dis-

posed within the casing and secured to the shaft, and slip joints connecting the casing and the header to permit the casing and the impeller and the shaft to be removed from the tank as a unit.

2. The combination defined in claim **1**, wherein the slip joints are annular in shape and concentrically disposed.

3. The combination defined in claim **1**, wherein the header comprises a generally cylindrical suction adapter extending upwardly inside the header and a discharge cone surrounding and spaced from the upper portion of the adapter.

4. The combination defined in claim **3**, wherein said adapter and said cone cooperate with said casing to form said slip joints.

5. The combination defined in claim **3**, wherein the header has an inlet opening with a vertically extending wall substantially aligned with said suction adapter and a discharge opening with an angularly extending wall substantially aligned with said discharge cone.

6. The combination defined in claim **1**, wherein the casing comprises two spaced concentric open bottom bowls with the space between the walls of the bowls constituting a discharge passage for the impeller.

7. The combination defined in claim **6**, wherein the inner bowl has a generally cylindrical suction approach therein with a wall connected to the header through one of said slip joints.

8. The combination defined in claim **7**, wherein the outer bowl has a wall connected to the header through another of said slip joints.

9. The combination defined in claim **6**, wherein the casing includes a diffuser disposed between the impeller and the discharge passage.

10. The combination defined in claim **9**, wherein the diffuser extends generally parallel to the axis of the impeller.

11. The combination defined in claim **9**, including a second impeller secured to the shaft with the diffuser for the first impeller discharging into the second impeller.

12. The combination defined in claim **11** including a second diffuser disposed between the second impeller and the discharge passage.

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U.S. Cl. X.R.

103—89, 103, 108; 222—233; 259—95, 96