Nov. 29, 1949 C. R. HOUGHTON 2,489,887

ROTARY PUMP

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Fig-2

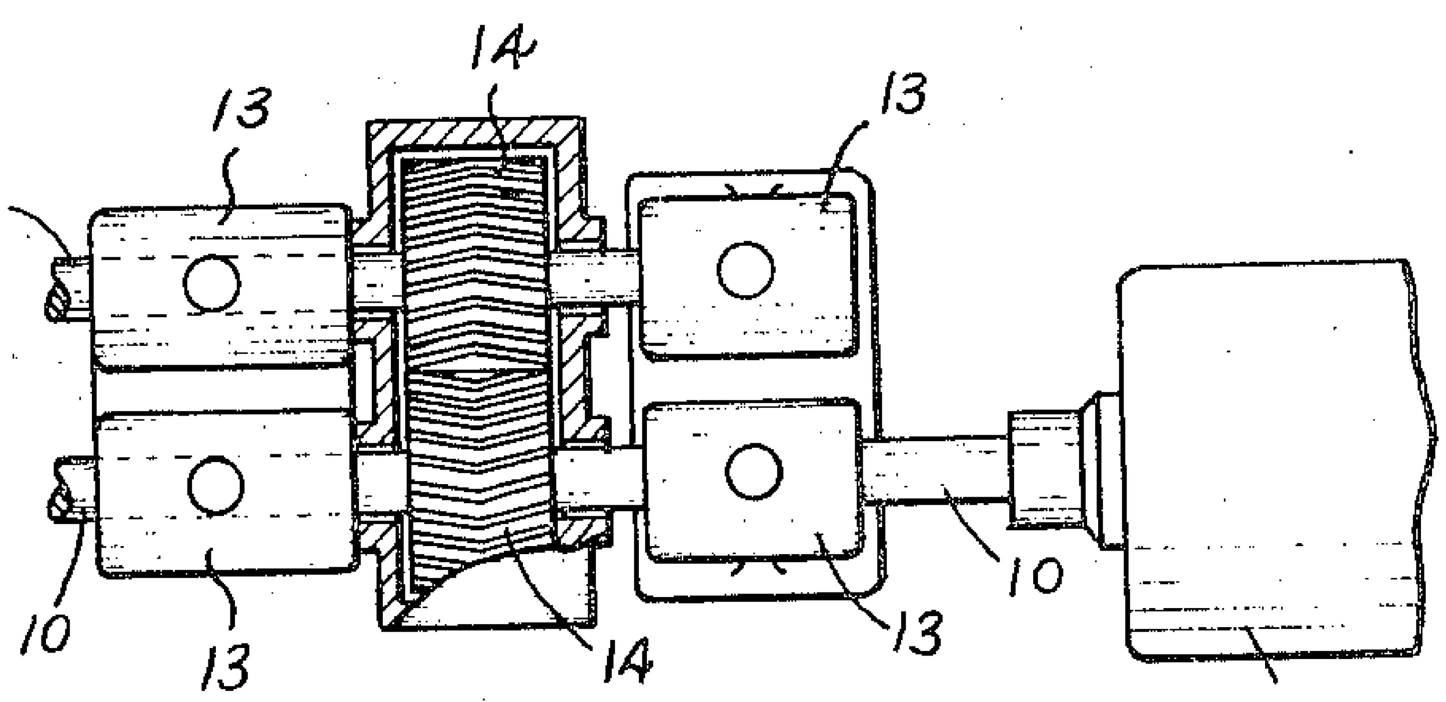


Fig-1

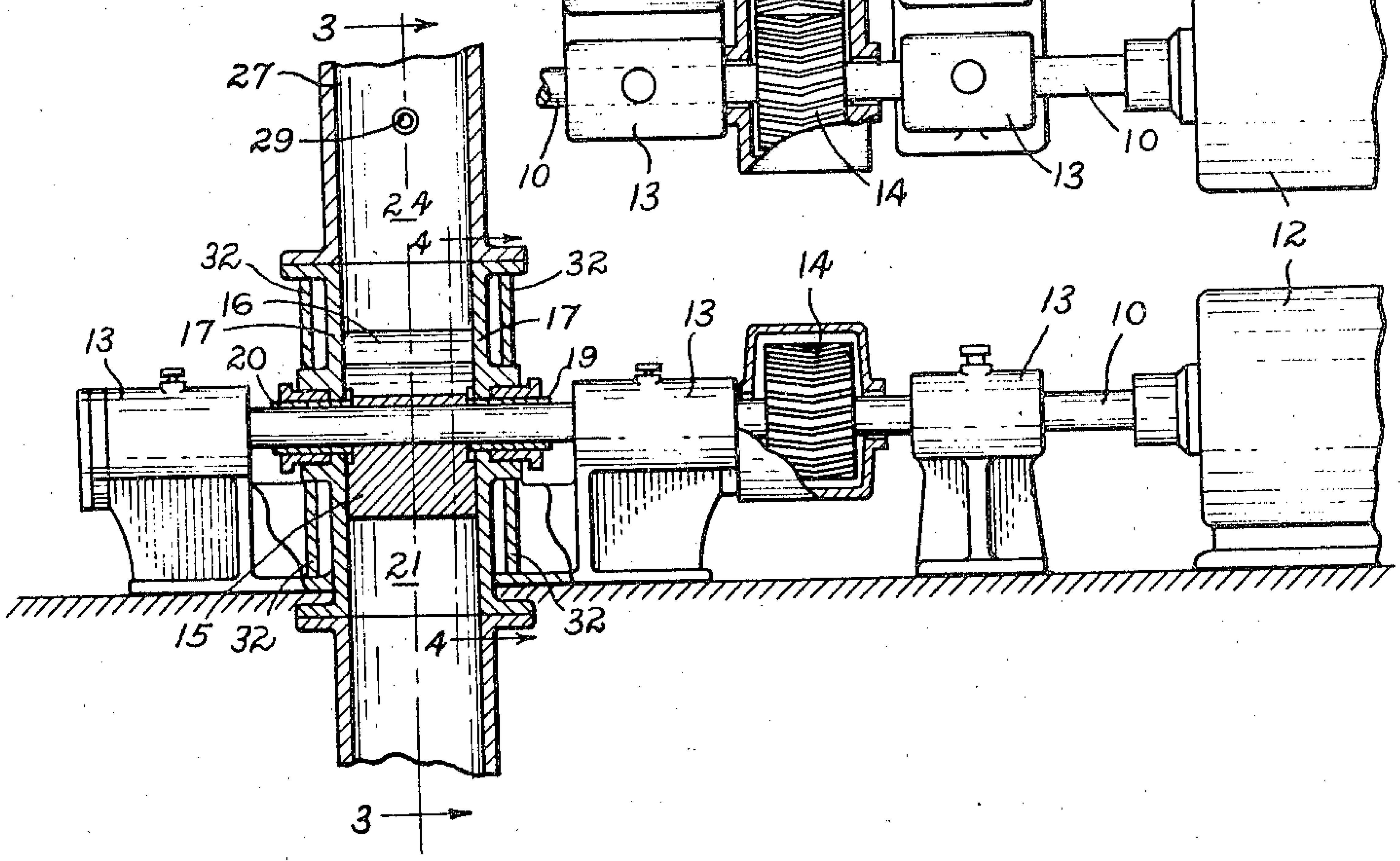


Fig-3

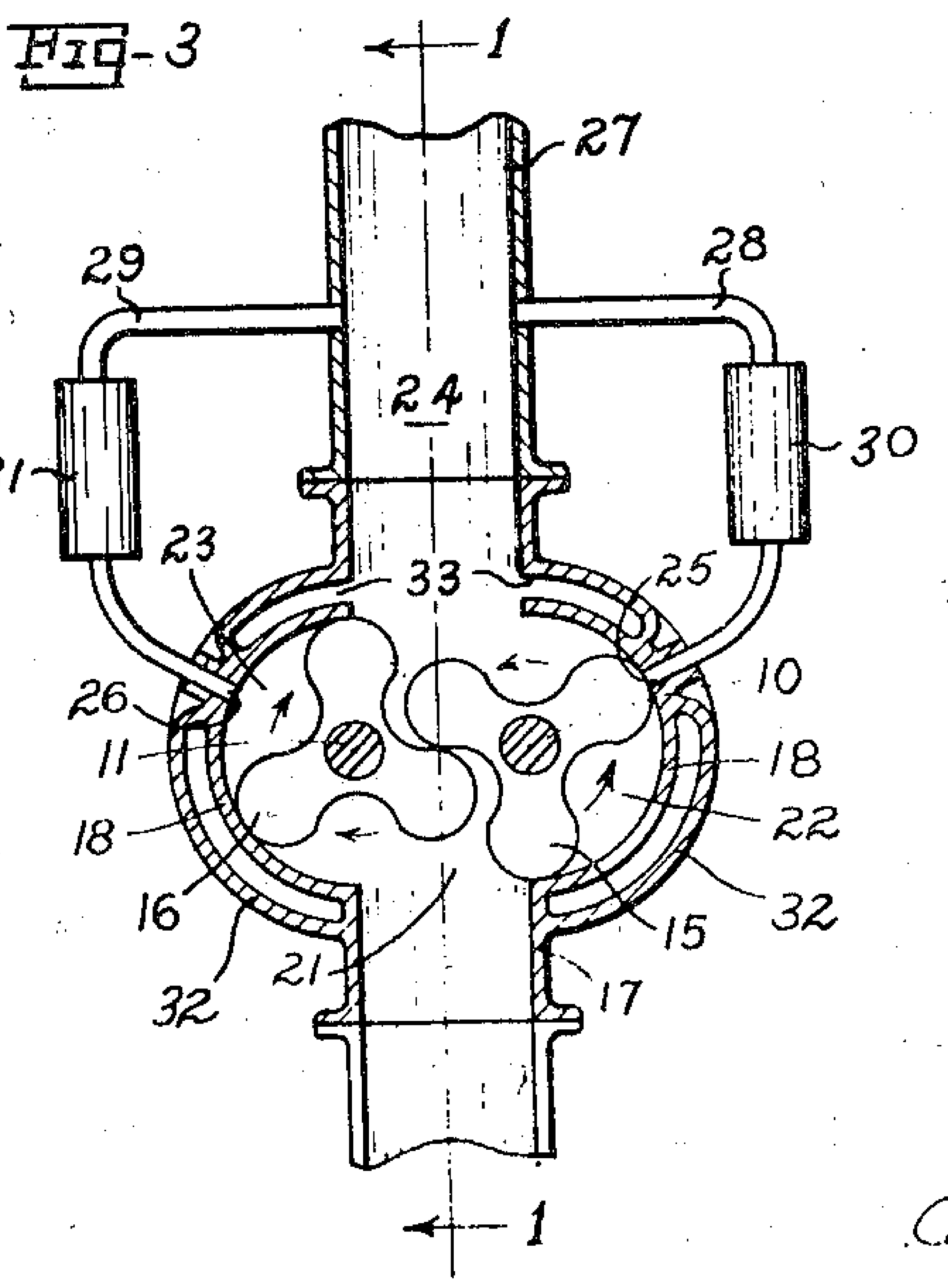
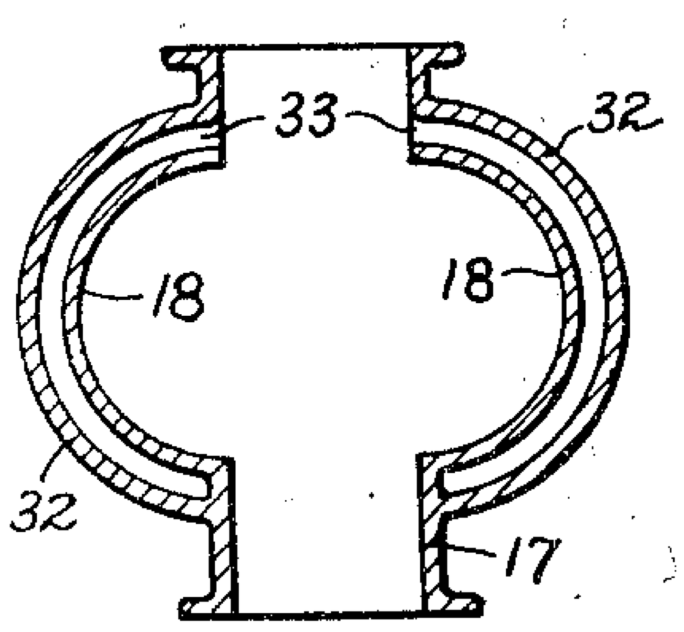


Fig-4



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ROTARY PUMP

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Fig-5

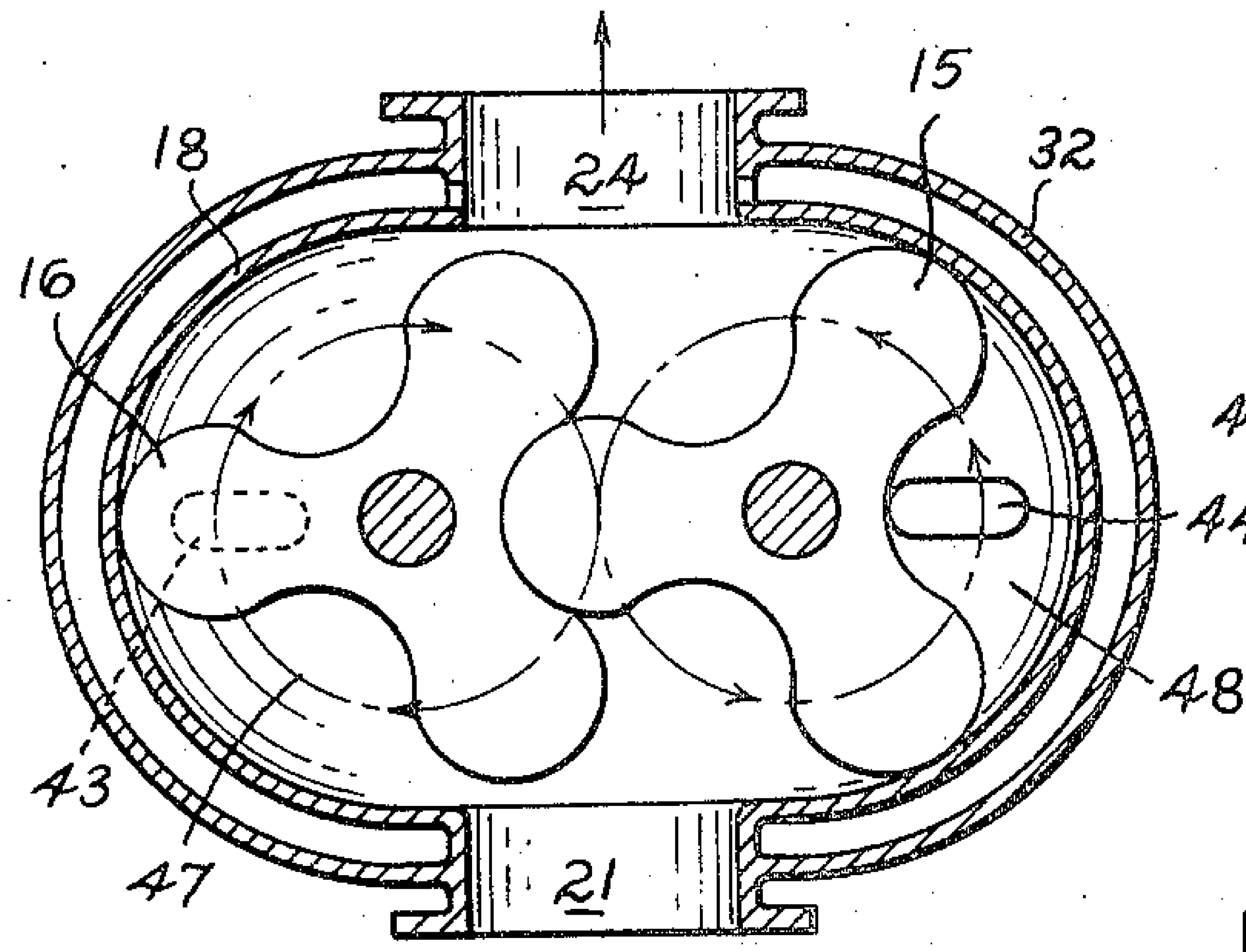


Fig-6

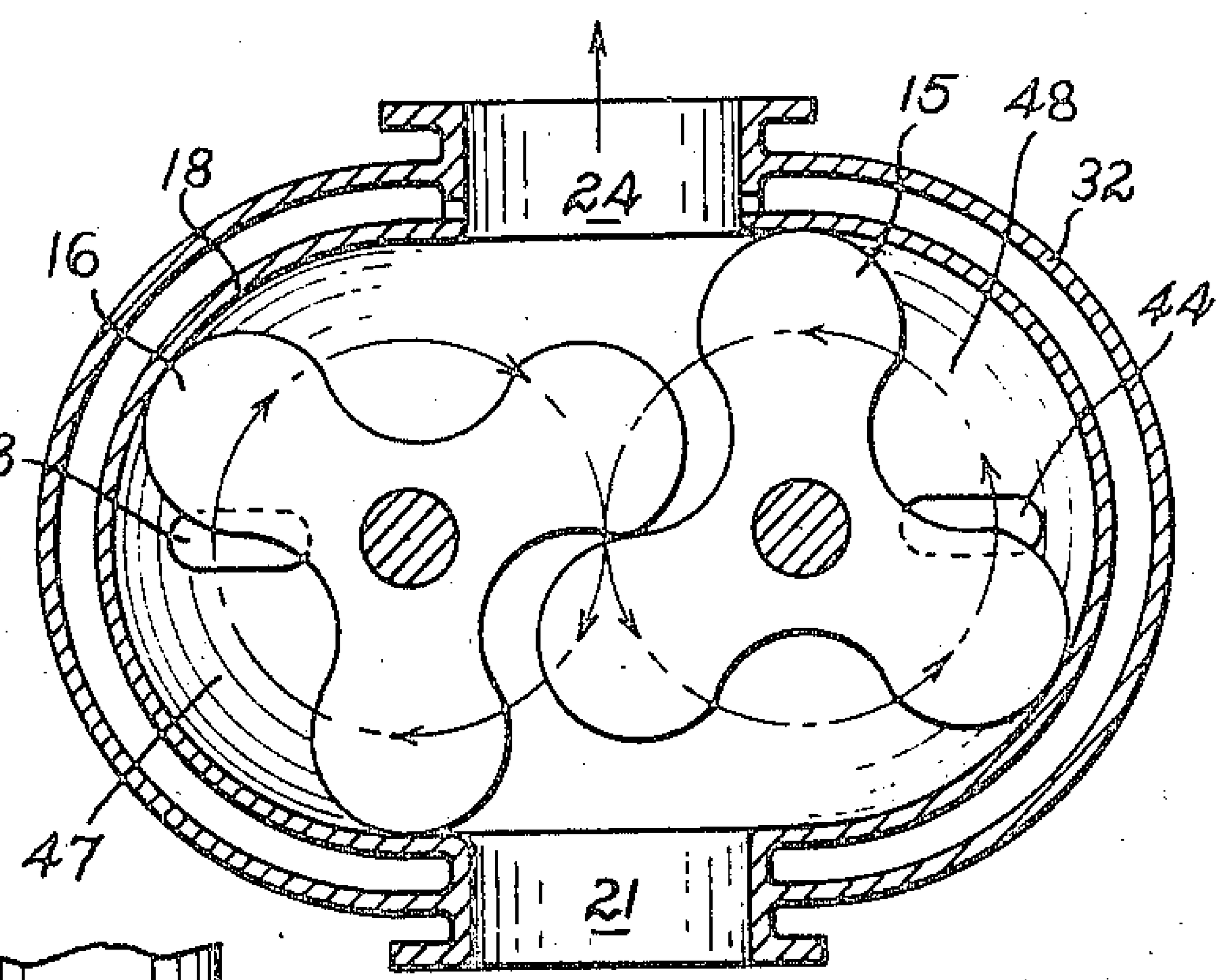
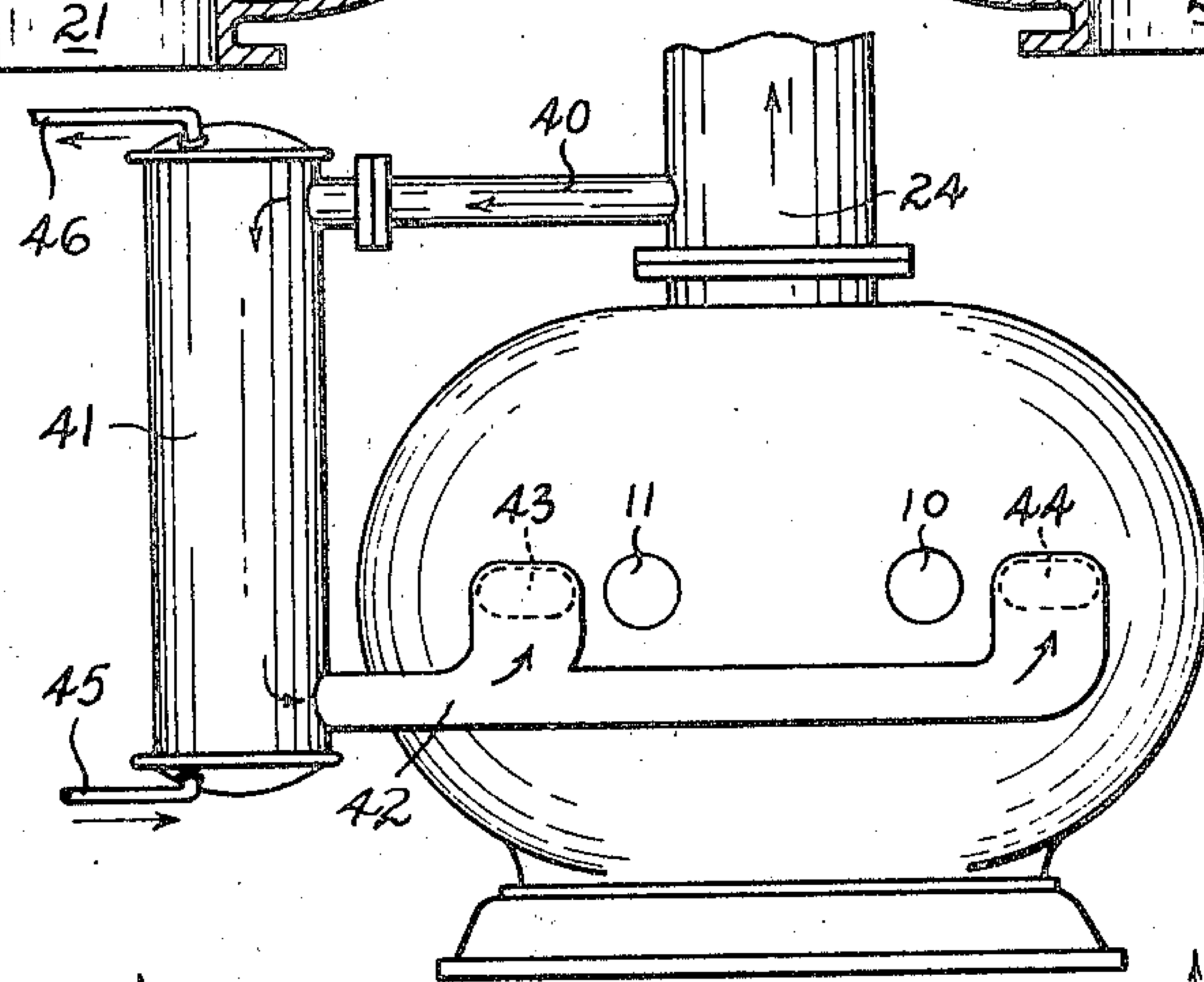
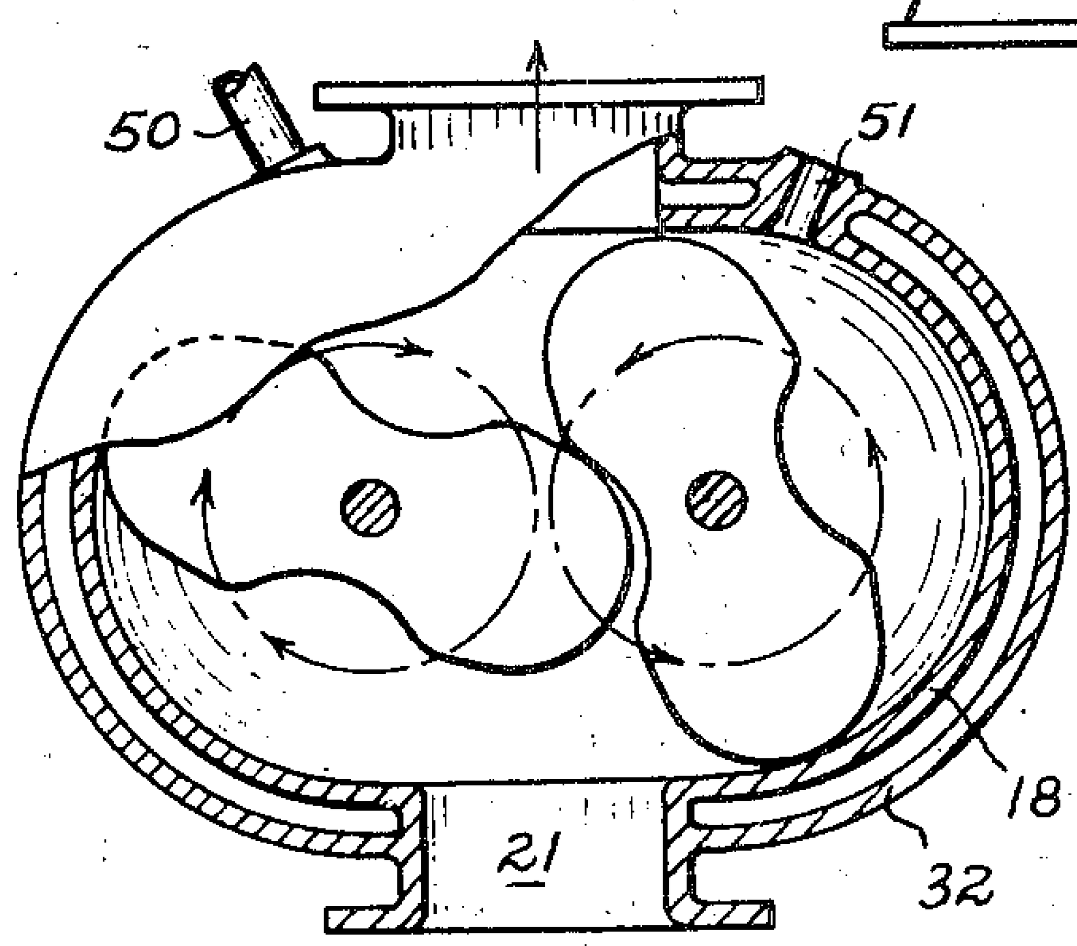


Fig-7





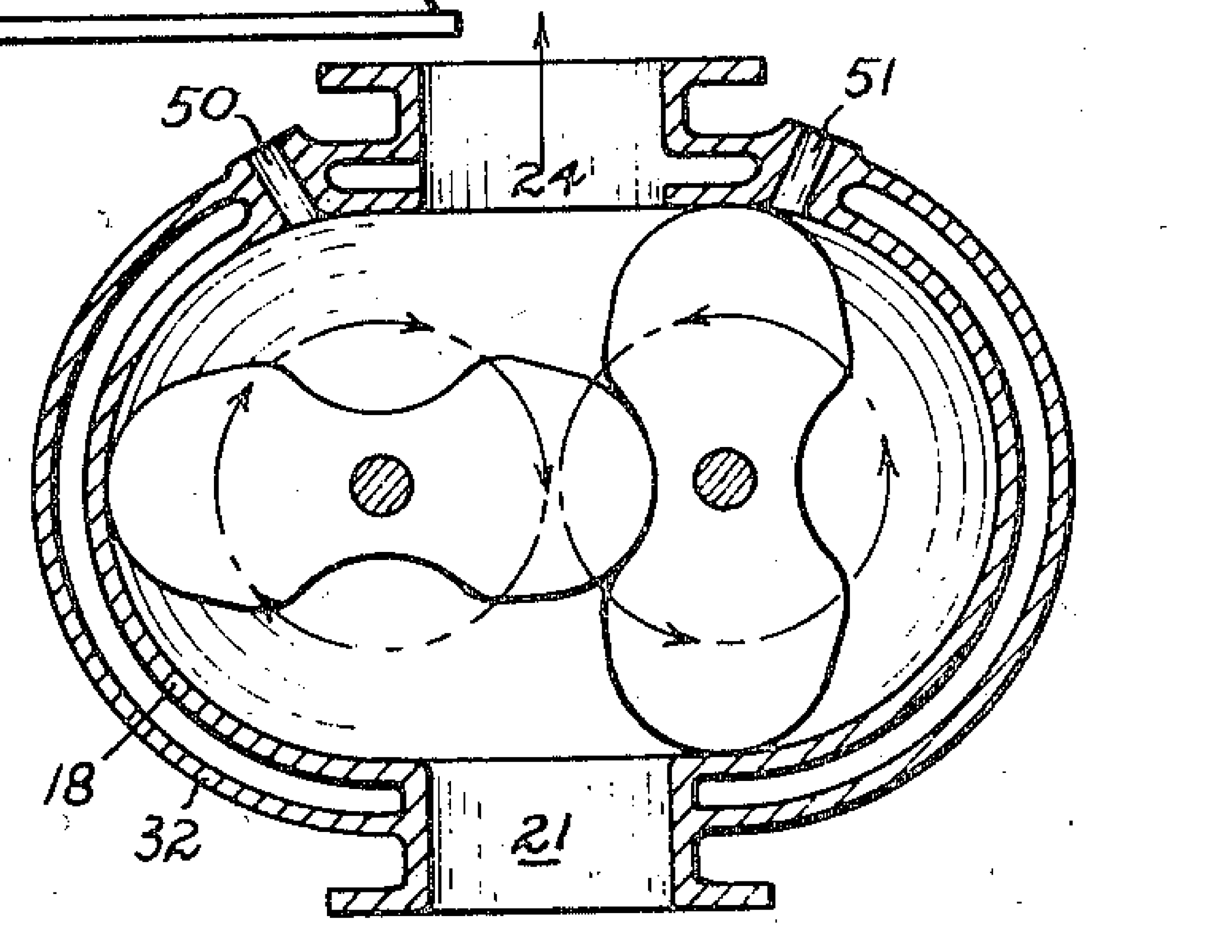


Fig-9

Fig-8

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Patented Nov. 29, 1949 **2,489,887**

UNITED STATES PATENT OFFICE

2,489,887

ROTARY PUMP

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Application July 11, 1946, Serial No. 682,827

18 Claims. (Cl. 230—210)

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This invention relates to apparatus for the compression of air or other gas, and more particularly to rotary positive displacement pumps or boosters for handling hot gases.

It is an object of this invention to provide rotary positive displacement pumps or boosters equipped with impellers having small operating clearances in which the proper operating clearances are maintained when handling hot gases, such that the pumps can successfully and efficiently handle hot gases.

Another object of this invention is to cool the impellers by introducing gas of a lower temperature into the gas being displaced by the pumps in order to maintain such proper operating clearances.

Another object of this invention is the provision of ports for introducing cooling gas in direct contact with the impellers, which ports are so located that the rotating impellers will act as valves to admit the cooling gas at the proper time for effective cooling without loss of efficiency of the pumps.

It is a still further object of this invention to utilize gas being handled to control the temperature of impellers and casings in such a manner that circulation of gas for temperature control is obtained without the use of additional outside energy.

Other objects and advantages of the invention will be apparent from the following description, the accompanying drawings, and the appended claims.

Rotary positive displacement pumps or boosters usually comprise two multilobed impellers rotating within a surrounding casing. The two impellers are mounted on parellel shafts which are geared together so that the impellers rotate in opposite directions. The contour and finish of the impellers and the accuracy of cut of the gears is such that a small, substantially gas-tight operating clearance of a few thousands of an inch or less is maintained between the impellers as they rotate. The surrounding casing has semi-cylindrical sides conforming to the paths described by the ends of the impeller lobes and is otherwise so shaped that a small, substantially gas-tight operating clearance of a few thousands of an inch or less is provided between the sides and the ends of the casing and the rotating impellers.

As the impellers revolve gas flows through a gas inlet into pockets formed by adjacent lobes of each impeller and the surrounding casing, is trapped in the pockets, is carried to a gas outlet,

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and is forced positively into a discharge pipe. During each complete revolution of the impellers this action is repeated a number of times equal to the total number of impeller lobes. At high impeller speeds this results in a practically constant flow of gas without surging.

In many cases it is edsirable to use gas pumps of the rotary positive displacement type for high pressures, with corresponding high heat due to the heat of compression. Highly heated gas is also encountered at lower ratios of compression when initially hot gas must be handled, the problem frequently arising of handling gases initially at 400° F. up to 100° F. When handling hot gases with compressors of the reciprocating type it is customary to water-jacket the cylinder to avoid overheating, and to provide the piston with snap rings which expand or contract as necessary to make close contact with the cylinder. Temperature differences between the cylinder and piston, resulting in unequal expansions, are not such a serious problem with that type of construction because of the tolerances permitted by the use of snap rings.

With rotary displacement pumps of the type described no satisfactory way to provide snap rings or the equivalent has been devised. Such rotary positive displacement pumps must be designed for operation with very small operating clearances between coacting impellers, and between impellers and the surrounding casing in order to provide substantially gas-tight seals against slip of gas through the pump wtih resultant loss of efficiency. If these clearances change as a result of the impellers reaching an appreciably higher temperature than the surrounding casing, the impellers may strike each other or the casing and failure or serious damage to the pump may result. Therefore, water-jacketing of the casing of such rotary pumps without cooling the impellers is a distinct hazard. Nevertheless such rotary pumps have many advantages. For example, the absence of sliding or wearing contacts within the casing makes it unnecessary to have lubricants in contact with the gas being handled, and there are no valves, springs, or similar small parts to fail or require adjustment or replacement. The gas is delivered without surging and is uncontaminated by lubricants or other pump liquids.

In accordance with this invention provision is made for introducing gas of a lower temperature into the casing in direct contact with the impellers in order to prevent overheating of the impellers and to maintain a substantially uniform temperature. Preferably this cooling gas is obtained by withdrawing gas from the high pressure outlet side of the pump, passing it through a gas cooler, and then introducing the cooled gas into the gas being displaced from the low pressure inlet side of the pump to the outlet side. It has been found that, when the cooling gas is introduced at the proper place in the pump in proper relation with the rotation of the impellers, the difference in pressures between the gas being displaced within the pump and the gas at the outlet side of the pump will produce the desired flow of gas without material loss of efficiency of the pump, and without the necessity of using any substantial additional power. Provision is also made for using the motion of the impellers to control the flow of cooling gas so that it is introduced at the proper times in proper coordination with the pump operation and with a minimum of auxiliary mechanism.

Since the casing surrounding the pump impellers would normally be cooled by the surrounding atmosphere as well as by the cooling gas introduced, it would tend to reach a temperature sufficiently below that of the impellers where the discharged gas was in a highly heated condition to cause the difficulties with loss of clearances as discussed above. Therefore provision is preferably made for circulating gas around the casing at sufficient temperature to maintain the casing at a temperature comparable with that of the impellers such that the small operating clearances are maintained sufficiently unchanged, or the temperatures of the casing and the impellers are correlated in such a way that this effect is obtained. Preferably turbulence in the outlet gas resulting from the pumping action of the impellers is used to cause circulation of outlet gas around the casing within a suitable casing jacket. Except in unusual cases this will maintain the casing at the proper temperature, and more positive means of heating will not be necessary.

Reference is made to the drawings which illustrate preferred embodiments of the invention, and in which like parts are designated by the same numerals.

Fig. 1 is a side elevation, partially in section, of a rotary displacement pump for compressing hot gases constructed in accordance with the present invention, the section being taken on the line 1—1 of Fig. 3;

Fig. 2 is a top view, partially in section, of a part of Fig. 1, showing how the impeller shafts are geared together;

Fig. 3 is a vertical sectional view on the line 3—3 of Fig. 1;

Fig. 4 is another vertical sectional view of the casing shown in Fig. 3, with the section taken on line 4—4 of Fig. 1;

Figs. 5 and 6 are vertical sectional views of the impellers and impeller casing of a modified pump construction;

Fig. 7 is an end view of the pump shown in Figs. 5 and 6 drawn to a different scale; and

Figs. 8 and 9 are vertical sectional views of the impellers and impeller casing of a pump having two-lobed impellers instead of the three-lobed impellers previously shown, illustrating application of the invention to this type of pump.

The rotary pump shown in Figs. 1 to 4 is of symmetrical construction about a plane passed midway between the two impeller shafts 10 and 11, perpendicular to a plane passed through the axes of the two shafts. The construction shown in Fig. 1, in which only shaft 10 can be seen, applies as well to the opposite side of the pump, with the exception that shaft 10 is driven by suitable means, such as an electric motor 12, whereas shaft 11 is driven by shaft 10. Shafts 10 and 11 are supported by bearings 13 and are geared together by gears, such as the herringbone gears indicated at 14, so that they turn in opposite directions at the same speed of rotation. Mounted on shafts 10 and 11 are two coacting three-lobed impellers 15 and 16. These impellers are of suitable contour, such as involute or cycloidal design, and interfit with each other in such manner that a very small and substantially gas-tight operating clearance is maintained between them in all positions of rotation. Surrounding the impellers is a casing 17, provided with semicylindrical sides 18 which conform to the paths described by the ends of the impeller lobes, in which the impellers rotate with a very small operating clearance so that a substantially gas-tight fit is provided. The casing is provided with packing glands 19 and 20 to form a gas-tight fit around the shafts 10 and 11. As the impellers rotate, a part of the gas in gas inlet opening 21 is trapped in gas pockets such as 22 and 23, formed by two adjacent impeller lobes and the surrounding case, and is carried around by the rotation of the impellers and forced into the high pressure gas outlet opening 24. Compression of the gas carried forward occurs as it is forced into space 24.

Ports 25 and 26 are provided in the semicylindrical sides 18 of the casing for introducing gas of a higher pressure and lower temperature into the gas pockets between impeller lobes in direct contact with the impellers. Each port is located approximately 120 degrees of an impeller revolution from the edge of the gas inlet opening 21 so that it is opened to a gas pocket immediately after the pocket is closed off from the gas inlet. In Fig. 3 impeller 15 is shown just as it is closing gas pocket 22 off from the gas inlet 21 and opening it to port 25. Impeller 16 is shown at a later point in its revolution after the gas pocket 23 has been opened to port 26.

The cooling gas to be introduced into the gas pockets may be from any source which is at a higher pressure than the gas in the pocket and is at a sufficiently low temperature to have the required cooling effect on the impellers. It will usually be of the same composition as the gas entering through gas inlet 21, but in some circumstances need not be. Preferably it is gas withdrawn from the outlet side of the pump, since this gas is already at a higher pressure than the gas in the gas pockets. As shown in Fig. 3 gas may be withdrawn from the outlet gas manifold 27 through pipes 28 and 29, passed through gas coolers, indicated diagrammatically at 30 and 31, to reduce its temperature the required amount, and introduced into the gas pockets through ports 25 and 26. The gas coolers 30 and 31 may be of suitable design, such as the shell and tube type in which cooling fluid such as water is circulated through a bank of pipes and the gas to be cooled is passed around the outside of the pipes, and should be of adequate capacity to give the desired cooling effect.

The gas in the gas pockets is initially at substantially the pressure of the inlet gas. Introduction of gas from the outlet side of the pump will raise the pressure in the gas pockets somewhat but the withdrawal of gas from the discharge manifold 27 is in relatively small quantity compared with the total discharge of the pump and does not materially reduce the output pressure. Since the impeller rotate at high speed and one pocket is being discharged into the gas outlet while another pocket is receiving gas through its gas port from the outlet gas, any pulsation of pressure in the outlet gas is negligible. There need be no overall loss of pump efficiency so long as the ports are located as described so that gas from the gas outlet cannot escape back into the gas inlet.

Also shown in Figs. 1, 3, and 4 is a jacket **32** surrounding the casing **17**. This may extend around both sides and the remainder of the casing as shown, or may extend around the semicylindrical sides **18** only, depending upon the temperature conditions which are encountered. The jacket provides a space within which a heating fluid may be circulated around the casing to heat the casing to a temperature which is of the same order as, and preferably slightly higher than, the temperature of the impellers. In this way undesirable cooling, or irregular temperature conditions of the casing, are prevented and the temperatures of the casing and of the impellers may thus be controlled so that the casing may always be heated sufficiently relative to the impellers to insure maintenance of the desired operating clearances and prevent undue expansion of impellers relative to each other and relative to the casing. While it is preferable that the casing be maintained at a higher temperature than the impellers, it is not desirable to have a large differential in temperature as the clearances would then become excessive. In some cases it may be sufficient to rely entirely on the jacket to maintain said casing at a temperature correlated to that of the impellers such that the required small operating clearances are maintained, and not provide for introducing cooling gas into the gas pockets.

The fluid circulated through the jacket may be any inert gas or liquid of suitable temperature. Preferably, however, the outlet gas from the pump is used to keep the casing at the required temperature. This may be done readily by providing openings **33** from the top of the jacket space into the gas outlet space **24** immediately above the impellers. At this point sufficient turbulence is created by the impellers to cause the gas to circulate through the jacket. In most cases no other openings need be provided into or out of the jacket space. However, in some cases it may be found desirable to connect the bottom of the jacket space to a subsequent part of the high pressure gas manifold by means of pipes, in order to obtain an increased circulation of gas. The temperature of the casing is preferably maintained at about the same temperature as the impellers so the same amount of expansion will take place in both.

Referring to Figs. 5, 6, and 7, a modification is shown in which cooling gas is admitted into the gas pockets through ports in the ends of the casing instead of through the semicylindrical sides as previously shown. Gas is withdrawn from the gas outlet side of the pump through pipe **40**, passes through gas cooler **41**, and the cooled gas passes through pipe **42** and into the gas pockets through ports **43** and **44**. Cooling fluid, such as water, is circulated through the cooler in the usual manner through pipes **45** and **46**. When the impellers are in the position shown in Fig. 5, port **43** is closed by impeller **16** and port **44** is open. Cooled gas enters through port **44** into gas pocket **48**, raising the pressure and lowering the temperature of the gas in the pocket, with resultant cooling of the impeller **15**. When the impellers have rotated a part of a revolution to the position shown in Fig. 6, port **44** is commencing to close and port **43** is commencing to open. Momentarily, gas pockets **47** and **48** are connected through pipe **42**. Since gas pocket **48** has assumed a pressure approaching that of gas outlet **24**, whereas gas pocket **47** contains gas at the lower pressure of gas inlet **21**, gas will pass from gas pocket **48** to gas pocket **47** without passing through the cooler **41**. However, this condition is of such short duration that it does not seriously interfere with the desired flow of cooling gas to the impellers. Therefore, it is practicable to use a single gas cooler, whereas the use of a single cooler in the arrangement shown in Fig. 3 would be less desirable because, when the ports are located in the semicylindrical sides of the casing, the ports are simultaneously open for an appreciable time. Another advantage to locating the ports in the ends of the casing is that the cooling gas is admitted in a more favorable position for cooling the impellers with less cooling of the casing sides. However, it may sometimes be desirable to use both the above modification and the previously described arrangement shown in Fig. 3 on the same pump, in order to admit cooling gas to the impeller at several points and obtain greater cooling effect.

Figs. 8 and 9 show how the invention may be adapted to a rotary displacement pump having two-lobed impellers. With the usual design of impellers and casing shown it will be necessary to locate the ports **50**, **51** for admitting cooling gas quite near to the high pressure outlet side of the pump **24**, in order to avoid flow of high pressure gas backward through the pump and into the lower pressure space **21**. Nevertheless there is a short interval of time during which a port will be open into a gas pocket before the gas pocket is open directly to the high pressure gas space **24**, as will be apparent by comparing Figs. 8 and 9, which show successive impeller positions. It would appear that the moment an impeller rotates to the position on the right of Fig. 9 there would be an instantaneous rush of gas from the space **24** into the advancing impeller pocket, but oscillograph readings show that there is a time lag and this would appear to provide for more effective functioning of ports **50**, **51** than is indicated by Figs. 8 and 9. The interval of time will be sufficient to start a rush of cooling gas into a gas pocket and materially assist in prevent overheating of the impellers.

If this usual design of two-lobed impeller pump is modified, as by providing for the cylindrical sides of the casing to follow the path of the ends of the impellers for a greater distance, it is possible to increase the interval of time between opening of the gas pocket to the cooling gas and opening of the gas pocket to the gas space **24**. The ports for cooling gas can also be arranged in the ends of the casing, as illustrated in Figs. 5, 6, and 7, but with two-lobed impellers the ports will usually have to be located close to the gas space **24** for the reasons discussed above.

While the forms of apparatus described and illustrated constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to these precise forms of apparatus, and changes may be made therein without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. A gas pump of the rotary displacement type for handling hot gases comprising a casing having a gas inlet and a gas outlet, a plurality of multilobed rotary interfitting impellers rotatably mounted in said casing with a small operating clearance between said impellers providing a substantially gas-tight seal and adapted to displace gas from said gas inlet to said gas outlet when rotated, and means for introducing cooling gas into said casing in direct contact with said impellers to prevent overheating of said impellers and to maintain said small operating clearance therebetween.

2. A gas pump of the rotary displacement type for handling hot gases comprising a casing having a gas inlet and a gas outlet, a plurality of multilobed rotary interfitting impellers rotatably mounted in said casing with a small operating clearance providing a substantially gas-tight seal and adapted to displace gas from said gas inlet to said gas outlet when rotated, means for introducing cooling gas into said casing in direct contact with said impellers to prevent overheating of said impellers, and means for circulating higher temperature gas around said casing to maintain said casing at a temperature comparable with that of said impellers such that said small operating clearance is maintained.

3. A gas pump of the rotary displacement type for handling hot gases comprising a casing having a gas inlet and a gas outlet, a pair of multilobed rotary interfitting impellers rotatably mounted in said casing with a small operating clearance between said impellers providing a substantially gas-tight seal and adapted to displace gas from said gas inlet to said gas outlet when rotated, a gas cooler, and means for passing gas from said gas outlet through said gas cooler and into said casing in direct contact with said impellers to prevent overheating of said impellers and to maintain said small operating clearance therebetween.

4. A gas pump of the rotary displacement type for handling hot gases comprising a jacketed casing having a gas inlet and a gas outlet, a plurality of multilobed rotary interfitting impellers rotatably mounted in said casing with a small operating clearance between said casing and said impellers providing a substantially gas-tight seal and adapted to displace gas from said gas inlet to said gas outlet when rotated, and means for circulating heated gas from said gas outlet through said jacket to maintain said casing at an increased temperature comparable with that of said impeller means such that said small operating clearance is maintained.

5. A gas pump of the rotary displacement type for handling hot gases comprising a pair of oppositely rotating multilobed interfitting impellers coacting to provide a small and substantially gas-tight operating clearance between said impellers in all positions, a casing provided with a gas inlet and a gas outlet and having substantially semicylindrical sides conforming to the paths described by the ends of the lobes of said rotating impellers surrounding said impellers with a small and substantially gas-tight operating clearance, gas pockets defined by adjacent lobes of said impellers and the surrounding casing adapted to trap gas at said gas inlet and displace the trapped gas into said gas outlet as said impellers rotate, and means for introducing cooling gas into said gas pockets to prevent overheating of said impellers and to maintain said small operating clearance between said impellers.

6. A gas pump of the rotary displacement type for handling hot gases comprising a pair of oppositely rotating multilobed interfitting impellers coacting to provide a small and substantially gas-tight operating clearance between said impellers in all positions, a casing provided with a gas inlet and a gas outlet and having substantially semicylindrical sides conforming to the paths described by the ends of the lobes of said rotating impellers surrounding said impellers with a small and substantially gas-tight operating clearance, gas pockets defined by adjacent lobes of said impellers and the surrounding casing adapted to trap gas at said gas inlet and displace the trapped gas into said gas outlet as said impellers rotate, a source of gas of lower temperature and higher pressure than the gas at said gas inlet, said casing having ports for introducing said lower temperature gas into said gas pockets to prevent overheating of said impellers and to maintain said small operating clearance between said impellers, and means for conducting said lower temperature gas from said source to said ports.

7. A gas pump of the rotary displacement type for handling hot gases comprising a pair of oppositely rotating multilobed interfitting impellers coacting to provide a small and substantially gas-tight operating clearance between said impellers in all positions, a casing provided with a gas inlet and a gas outlet and having substantially semicylindrical sides conforming to the paths described by the ends of the lobes of said rotating impellers surrounding said impellers with a small and substantially gas-tight operating clearance, gas pockets defined by adjacent lobes of said impellers and the surrounding casing adapted to trap gas at said gas inlet and displace the trapped gas into said gas outlet as said impellers rotate, a source of gas of lower temperature and higher pressure than the gas at said gas inlet, the semicylindrical sides of said casing having ports for introducing said lower temperature gas into said gas pockets to prevent overheating of said impellers and to maintain said small operating clearance between said impellers, and means for conducting said lower temperature gas from said source to said ports.

8. A gas pump of the rotary displacement type for handling hot gases comprising a pair of oppositely rotating multilobed interfitting impellers coacting to provide a small and substantially gas-tight operating clearance between said impellers in all positions, a casing provided with a gas inlet and a gas outlet and having substantially semicylindrical sides conforming to the paths described by the ends of the lobes of said rotating impellers surrounding said impellers with a small and substantially gas-tight operating clearance, gas pockets defined by adjacent lobes of said impellers and the surrounding casing adapted to trap gas at said gas inlet and displace the trapped gas into said gas outlet as said impellers rotate, a source of gas of lower temperature and higher pressure than the gas at said gas inlet, said casing having ports located adjacent to said semicylindrical sides for introducing said lower temperature gas into said gas pockets to prevent overheating of said impellers and to maintain said small operating clearance between said impellers, and means for conducting said lower temperature gas from said source to said ports.

9. A gas pump of the rotary displacement type

for handling hot gases comprising a pair of oppositely rotating multilobed interfitting impellers coacting to provide a small and substantially gas-tight operating clearance between said impellers in all positions, a casing provided with a gas inlet and a gas outlet and having substantially semicylindrical sides forming to the paths described by the ends of the lobes of said rotating impellers surrounding said impellers with a small and substantially gas-tight operating clearance, gas pockets defined by adjacent lobes of said impellers and the surrounding casing adapted to trap gas at said gas inlet and displace the trapped gas into said gas outlet as said impellers rotate, said casing having ports for introducing gas into said gas pockets, a gas cooler, means for conducting gas from said gas outlet to said gas cooler to cool said gas, and means for conducting said cooled gas from said gas cooler to said ports and into said gas pockets to prevent overheating of said impellers and to maintain said small operating clearance between said impellers.

10. A gas pump of the rotary displacement type for handling hot gases comprising a pair of oppositely rotating multilobed interfitting impellers coacting to provide a small and substantially gas-tight operating clearance between said impellers in all positions, a casing provided with a gas inlet and a gas outlet and having substantially semicylindrical sides conforming to the paths described by the ends of the lobes of said rotating impellers surrounding said impellers with a small and substantially gas-tight operating clearance, gas pockets defined by adjacent lobes of said impellers and the surrounding casing adapted to trap gas at said gas inlet and displace the trapped gas into said gas outlet as said impellers rotate, said casing having ports adjacent said semicylindrical sides of said casing of such size and so located that said ports are closed during the rotation of said impellers except during the time when said gas pockets are closed off from said gas inlet and from said gas outlet, said ports being open to substantially only one gas pocket at a time, a gas cooler, means for conducting gas from said gas outlet to said gas cooler to cool said gas, and means for conducting said cooled gas from said gas cooler to said ports and into said gas pockets to prevent overheating of said impellers and to maintain said small operating clearance between said impeller.

11. A gas pump of the rotary displacement type for handling hot gases comprising a pair of oppositely rotating multilobed interfitting impellers coacting to provide a small and substantially gas-tight operating clearance between said impellers in all positions, a casing provided with a gas inlet and a gas outlet and having substantially semicylindrical sides conforming to the paths described by the ends of the lobes of said rotating impellers surrounding said impellers with a small and substantially gas-tight operating clearance, gas pockets defined by adjacent lobes of said impellers and the surrounding casing adapted to trap gas at said gas inlet and displace the trapped gas into said gas outlet as said impellers rotate, means for introducing cooling gas into said trapped gas to prevent overheating of said impellers, and means for circulating heating gas around said casing to maintain said casing at a temperature relative to said impellers which will maintain said small clearances.

12. A gas pump of the rotary displacement type for handling hot gases comprising a pair of oppositely rotating multilobed interfitting impellers coacting to maintain a small and substantially gas-tight operating clearance between said impellers in all positions, a jacketed casing provided with a gas inlet and a gas outlet and having substantially semicylindrical sides conforming to the paths described by the ends of the lobes of said rotating impellers surrounding said impellers with a small and substantially gas-tight operating clearance, gas pockets defined by adjacent lobes of said impellers and the surrounding casing adapted to trap gas at said gas inlet and to displace said trapped gas from said gas inlet to said gas outlet as said impellers rotate, a gas cooler, means for conducting gas from said gas outlet to said gas cooler to cool said gas, means for conducting said cooled gas from said gas cooler through said casing and into said gas pockets to prevent overheating of said impellers, and means for circulating gas from said gas outlet around said casing within said casing jacket to maintain said casing at a temperature comparable with that of said impellers such that said small operating clearances are maintained.

13. A gas pump of the rotary displacement type for handling hot gases comprising a pair of oppositely rotating multilobed interfitting impellers coacting to maintain a small and substantially gas-tight operating clearance between said impellers in all positions, a jacketed casing provided with a gas inlet and a gas outlet and having substantially semicylindrical sides conforming to the paths described by the ends of the lobes of said rotating impellers surrounding said impellers with a small and substantially gas-tight operating clearance, gas pockets defined by adjacent lobes of said impellers and the surrounding casing adapted to trap gas at said gas inlet and to displace said trapped gas from said gas inlet to said gas outlet as said impellers rotate, a gas cooler, means for conducting gas from said gas outlet to said gas cooler to cool said gas, means for conducting said cooled gas from said gas cooler through said casing and into said gas pockets to prevent overheating of said impellers, said casing jacket having openings into said gas outlet providing for circulation of gas from said gas outlet around said casing within said jacket to maintain said casing at a temperature comparable with that of said impellers such that said small operating clearances are maintained.

14. A gas pump of the rotary displacement type for handling hot gases comprising a pair of oppositely rotating multilobed interfitting impellers coacting to maintain a small and substantially gas-tight operating clearance between said impellers in all positions, a jacketed casing provided with a gas inlet and a gas outlet and having substantially semicylindrical sides conforming to the paths described by the ends of the lobes of said rotating impellers surrounding said impellers with a small and substantially gas-tight operating clearance, gas pockets defined by adjacent lobes of said impellers and the surrounding casing adapted to trap gas at said gas inlet and to displace said trapped gas from said gas inlet to said gas outlet as said impellers rotate, and means for circulating gas around said casing within said casing jacket to maintain said casing at a temperature correlated to that of said impellers such that said small operating clearance between said impellers and said casing is maintained.

15. A gas pump of the rotary displacement type for handling hot gases comprising a pair of oppositely rotating multilobed interfitting impellers coacting to maintain a small and substantially

gas-tight operating clearance between said impellers in all positions, a jacketed casing provided with a gas inlet and a gas outlet and having substantially semicylindrical sides conforming to the paths described by the ends of the lobes of said rotating impellers surrounding said impellers with a small and substantially gas-tight operating clearance, gas pockets defined by adjacent lobes of said impellers and the surrounding casing adapted to trap gas at said gas inlet and to displace said trapped gas from said gas inlet to said gas outlet as said impellers rotate, and means for circulating gas from said gas outlet around said casing within said casing jacket to maintain said casing at a temperature correlated to that of said impellers such that said small operating clearance between said impellers and said casing is maintained.

16. A gas pump of the rotary displacement type for handling hot gases comprising a pair of oppositely rotating multilobed interfitting impellers coacting to maintain a small and substantially gas-tight operating clearance between said impellers in all positions, a jacketed casing provided with a gas inlet and a gas outlet and having substantially semicylindrical sides conforming to the paths described by the ends of the lobes of said rotating impellers surrounding said impellers with a small and substantially gas-tight operating clearance, gas pockets defined by adjacent lobes of said impellers and the surrounding casing adapted to trap gas at said gas inlet and to displace said trapped gas from said gas inlet to said gas outlet as said impellers rotate, said casing jacket having openings into said gas outlet providing for circulation of gas from said gas outlet around said casing within said jacket to maintain said casing at a temperature correlated to that of said impellers such that said small operating clearance between said impellers and said casing is maintained.

17. A gas pump of the rotary displacement type for handling hot gases comprising a pair of oppositely rotating multilobed interfitting impellers coacting to maintain a small and substantially gas-tight operating clearance between said impellers in all positions, a jacketed casing provided with a gas inlet and a gas outlet and having substantially semicylindrical sides conforming to the paths described by the ends of the lobes of said rotating impellers surrounding said impellers with a small and substantially gas-tight operating clearance, gas pockets defined by adjacent lobes of said impellers and the surrounding casing adapted to trap gas at said gas inlet and to displace said trapped gas from said gas inlet to said gas outlet as said impellers rotate, said casing jacket having openings into said gas outlet so located that turbulence created by the rotation of said impellers causes circulation of gas from said gas outlet around said casing within said jacket and maintains said casing at a temperature comparable to that of said impellers such that said small operating clearance between said impellers and said casing is maintained.

18. A gas pump of the rotary displacement type comprising a casing having a gas inlet and a gas outlet, a plurality of multilobed interfitting rotary impellers rotatably mounted in said casing with a small operating clearance providing a substantially gas-tight seal adapted to displace gas from said gas inlet to said gas outlet when rotated with resulting increase in the temperature of the gas, means for introducing a cooling fluid into said casing in direct contact with said impellers to lower the temperature thereof, and means for applying heat to said casing to raise the temperature thereof toward that of said impeller means to provide for maintaining said small operating clearance.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,058,646	Tomlinson	Apr. 8, 1913
1,475,683	Carrey	Nov. 27, 1923
1,558,639	Schmied	Oct. 27, 1925
1,893,171	Kagi	Jan. 3, 1933

FOREIGN PATENTS

Number	Country	Date
313,815	Italy	Jan. 9, 1934
664,937	Germany	Sept. 13, 1938