June 13, 1967 P. P. TERRANO 3,324,799

RADIAL STAGING FOR REENTRY COMPRESSOR

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Fig. 1

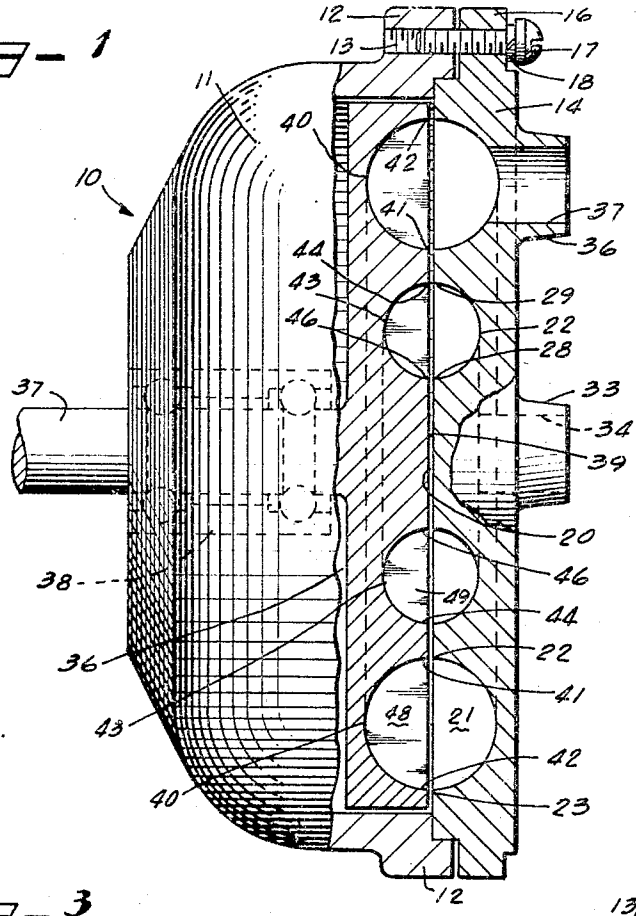
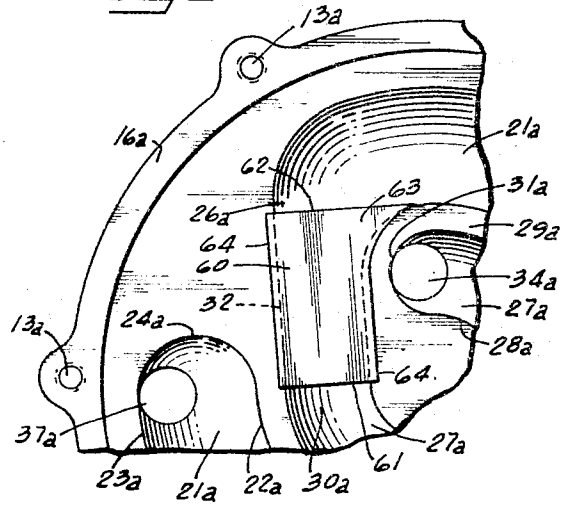


Fig. 3



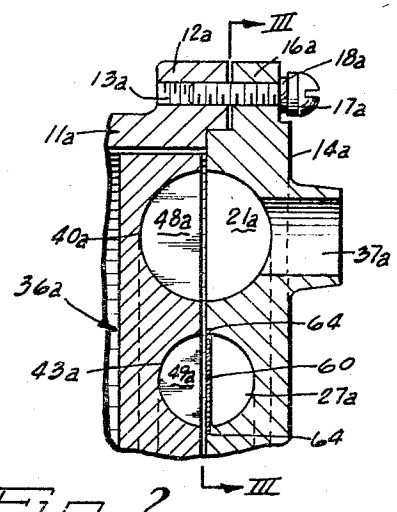


Fig. 2

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Fig. 4

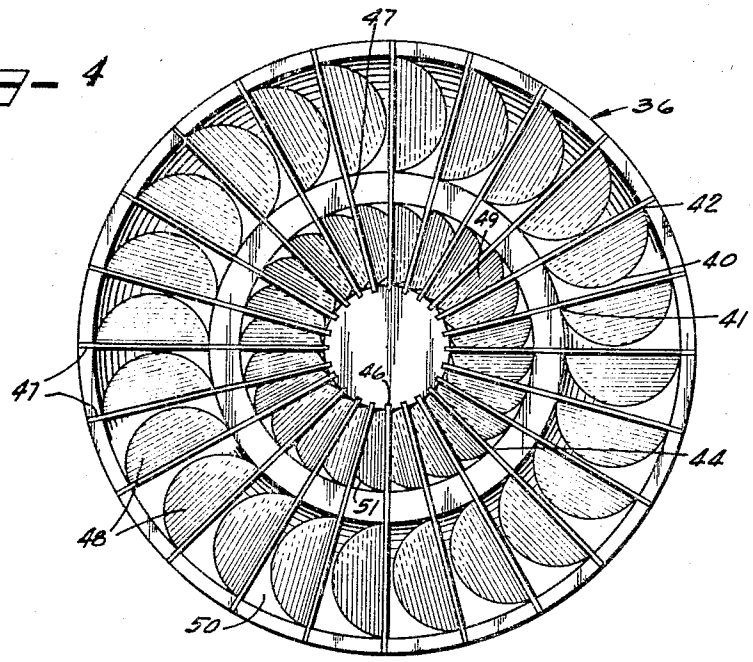
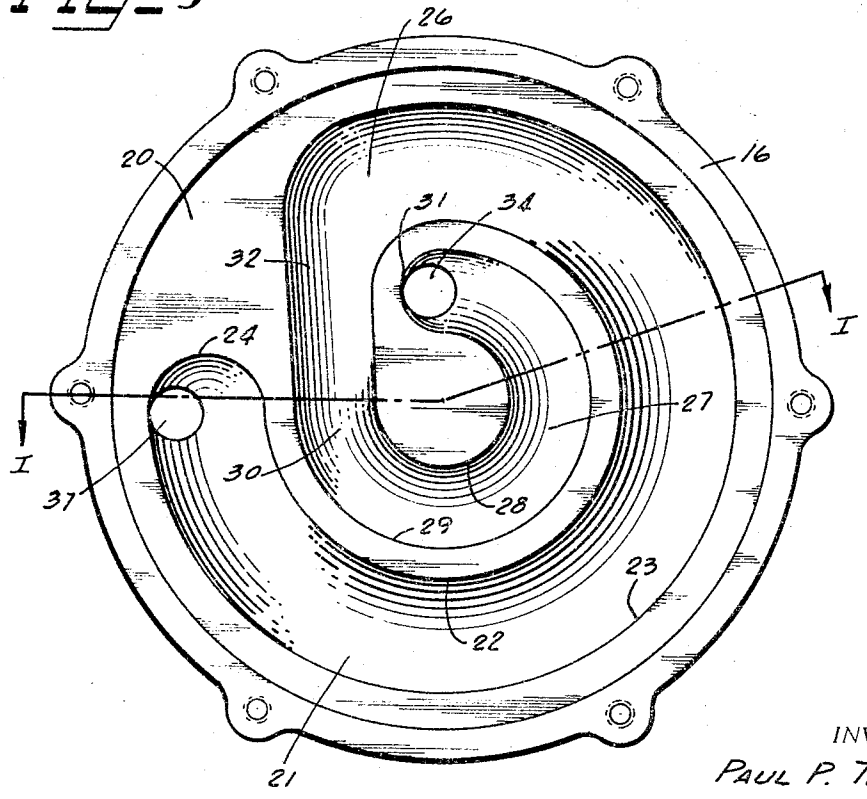


Fig. 5



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RADIAL STAGING FOR REENTRY COMPRESSOR

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3 Claims. (Cl. 103—96)

This invention relates generally to reentry compressors and more particularly relates to a reentry compressor having a single sided rotor and wherein multiple staging is accomplished by interconnecting multiple concentric pumping channels in series flow relation, the multiple concentric channels being disposed in confronting registry with multiple concentric rows of blades having an optimum number of blades and a predetermined diameter ratio.

Multiple staging of reentry compressors is frequently desirable as increased pressures may be required for particular applications. In accordance with the principles of the present invention, two or more stages can be obtained in a single sided rotor by disposing multiple concentric rows of blades and pumping passages in spaced relation relative to rotational axis. With such an arrangement, the inlet and outlet ports may be interchanged and the basic arrangement can either be repeated or combined in series or in parallel. Such a multistaging arrangement avoids most of the flow losses inherent in other designs and more nearly maintains the continuity of fluid flow from the inlet to the outlet.

It is an object of the present invention, therefore, to provide a means of multistaging a reentry compressor of the type utilizing a single sided rotor.

Another object of the present invention is to provide a multistaging arrangement for a reentry compressor wherein the inlet and outlet ports may be selectively interchanged with no change in the basic principle.

Another object of the present invention is to provide a multistaging arrangement for a reentry compressor which can be repeated and combined in series or parallel.

A still further object of the present invention is to provide a multistaging arrangement for a reentry compressor wherein flow losses are minimized and wherein the continuity of fluid flow from the inlet and outlet is preserved.

Many other objects, features, advantages and additional objects of the present invention will become manifest to those versed in the art upon making reference to the detailed description which follows and the accompanying sheets of drawings in which an exemplary form of a reentry compressor is shown by way of illustrative example.

On the drawings.

FIGURE 1 is an elevational view with parts broken away and shown in cross-section illustrating an exemplary form of a reentry compressor embodying the principles of the present invention;

FIGURE 2 is a fragmentary cross-sectional view similar to FIGURE 1 but showing a covered interconnecting passageway between stages;

FIGURE 3 is a cross-sectional view taken generally on the plane of line III—III of FIGURE 2 and illustrates additional details of construction of the covering plate;

FIGURE 4 is an elevational view showing additional details of construction of the rotor; and

FIGURE 5 is an elevational view of the cover member provided in accordance with the principles of the present invention and showing at line I—I the plane of the cross-sectional portions of FIGURE 1.

As shown on the drawings:

Fluid pumps which are commonly known as drag pumps, offer characteristics in a centrifugal compressor which fall somewhere between those of the positive displacement pump and the centrifugal pump. This means the single stage pump produces a medium pressure at the output when running at a medium speed, as compared with either of the other two types. Because of those characteristics and the fact that it is not a positive displacement pump, there are many applications where such a pump should do a good job and be economically feasible as compared to the other two types.

In some instances, it is desirable to have a discharge pressure in the same magnitude as the positive displacement pump while running in the same speed magnitude. In accordance with the principles of the present invention, such objective can be accomplished by placing additional stages on the drag pump without increasing the size and complexity of the pump by providing multiple concentric rows of blades and pumping passages which are interconnected or interrelated to afford a multistaging arrangement.

The pump of the present invention is shown generally at **10** and comprises a casing **11** having a flange **12** in which is formed a plurality of threaded apertures **13**. A cover **14**, similarly flanged as at **16**, passes a plurality of fasteners **17** which together with lock washers **18** may be used to fasten the casing **11** and the cover **14** in firm assembly with one another.

The cover **14** is particularly characterized by an inner face **20** having formed therein a semi-toroidal circumferentially extending pumping duct **21** having an inner wall **22** and an outer wall **23**, both of which are arranged in generally concentric relation to the axis of the pump, thereby to form a pumping duct which extends circumferentially from an end portion **24** to an end portion **26**.

In accordance with the principles of the present invention, a second pumping duct is shown at **27** and is likewise of semi-toroidal configuration extending circumferentially and having an inner wall **28** and an outer wall **29** and extending from a portion shown at **30** to an end portion **31**. The pumping channel or duct **21** is interconnected with the pumping channel or duct **27** by means of a passageway **32**.

In the form of the invention illustrated, the cover **14** has a boss **33** in which is formed an inlet port **34** communicating with the inner pumping duct **27** near the end portion **31** thereof.

The cover **14** is further characterized by a boss **36** in which is formed an outlet port **37**, which outlet port **37** intersects the outer pumping channel or duct **21** near the end portion **24** thereof. Accordingly, fluid entering the inlet port **31** will pass through the pumping channel or duct **27** and thence through the interconnecting passage **32** into the end portion **26** of the outer pumping channel or duct **21** and will then pass through the outlet port **37**.

Referring now to FIGURES 1 and 4, it may be noted that a rotor is provided at **36** and includes a shaft **37** which is journaled in a bearing assembly shown in dotted outline generally at **38**. The rotor **36** has a radial face **39** which is particularly characterized by having formed therein semi-toroidal circumferentially continuous vane ducts which are concentric with respect to one another and which are spaced to lie in confronting registry with the pumping channels or ducts **21** and **27**. In this connection, note that the face **39** has an outer circumferentially extending recess formed therein which is identified at **40** including an inner wall **41** and an outer wall **42**.

There is further provided an annular circumferentially extending recess **43** having an outer wall **44** and an inner wall **46**.

In the course of fabrication, the rotor **36** is provided with a plurality of slots which extend transversely of the corresponding recesses **40** and **43** and which slots are more specifically identified in FIGURE 4 at **47**. Received within each slot **47** is a vane **48** for the outer recess or vane duct **40** and **49** for the inner recess or vane duct **43**. Thus, a plurality of vanes **48** are disposed in an annular

row in circumferentially spaced relation so that all of the vanes **48** and **49**, in the respective recesses **40** and **43**, form a plurality of impeller pockets **50** and **51** adapted to be moved upon rotation of the impeller **36** within the casing formed by the cover **14** and the casing **11**.

As will be noted upon inspecting the structure shown in the drawings, the two concentric rows of blades **48** and **49** have an optimum number of blades and an appropriate diameter ratio. In the arrangement shown, the inlet port **34** is near the center and the outlet port **37** is near the outside diameter, however, it will be readily recognized by those versed in the art that the inlet and outlet ports may be interchanged with no change in the basic principle. An inlet at the outer diameter is desirable for certain combinations of flow, pressure and speed, while an inlet at the center is indicated for certain other combinations. Further, the basic arrangement of multiple concentric channels and blade rows can be repeated and can be combined either in series or in parallel. Further, three or more concentric channels could also be used rather than two, as shown in the exemplary structure, and it will be readily recognized that if desired, partial channels could be used instead of circumferentially continuous channels.

Further, although in FIGURE 5 the interconnecting passage **32** is shown uncovered, it is also possible to provide a cover for such passage in order to cut down losses and in this regard a cover is shown in the arrangement of FIGURES 2 and 3 wherein like parts are designated by like numbers but with a suffix "*a*." As shown in FIGURES 2 and 3, the area adjacent the interconnecting passage **32***a* is recessed at its edges, thereby to receive and seat a sheet metal cover **60** having a narrow end **61** located adjacent the end portion **30***a* of the inner duct **27***a* to an end portion **62** which extends transversely as at **63** to overlie the end portion **26***a* at the end of the outer pumping duct **21***a*. The recess portion adjacent the edges of the interconnecting passage **32***a* are shown at **64**.

By virtue of the provision made, continuity of fluid flow from the inlet port **34** to the outlet port **37** is afforded and multistaging is accomplished with a minimum of flow loss.

The number of blades, the diameter ratio and the cant angle may be different in each row of blades, depending on performance criteria. In such event, the blades may be assembled to the rotor by means other than the slotting procedure described by way of exemplification.

It may also be noted that it is desirable that the inlet port be located near the inner diameter of the corresponding channel while the outlet port should be located near the outer wall of the corresponding channel.

Although minor modifications might be suggested by those versed in the art, it should be understood that I wish to embody within the scope of the patent warranted hereon all such modifications as reasonably and properly come within the scope of my contribution to the art.

I claim as my invention:

1. A fluid pump of the drag type comprising

a casing having an inlet opening for connection to a source of fluid to be pumped and

an outlet opening for direction of the pumped fluid to a point of utilization,

said casing having a radial face formed internally thereof characterized by having formed therein inner and outer concentrically disposed annular pumping ducts communicating with said inlet and outlet ports,

a rotor in said casing having a drive shaft connected thereto,

said rotor having a radial face including annular recesses disposed in concentric relation for registry with said pumping ducts,

said rotor having a plurality of circumferentially spaced slots each extending across said annular recesses,

and vane means in said slots to form with said recesses a plurality of impeller pockets in each respective recess,

and interconnecting passage means in said casing disposed between said pumping ducts to interconnect said pumping ducts in staged flow relation, said radial face of said casing being recessed adjacent said interconnecting passage means, and a thin cover member received and seated in said recessed portion of said casing face to overlie said interconnecting passage means and the adjacent end portions of said inner and outer ducts, thereby to insure continuity of fluid flow with minimum flow loss.

2. A reentry compressor comprising

a single sided rotor having multiple concentric rows of blades,

a casing having a wall extending closely adjacent said rotor and having formed therein multiple concentric pumping channels confronting said rows of blades,

said wall having passage means formed therein extending radially and interconnecting said concentric pumping channels in flow relation,

and interchangeable inlet and outlet ports formed in said casing communicating with said respective ends of said concentric pumping channels to direct pumping fluid to and from the pump, and

means forming a cover for said passage means to reduce flow losses between the concentric pumping channels.

3. A two stage pump comprising

a rotor having a radial face,

two concentric blade channels of substantially semi-toroidal cross-section in said face,

a plurality of circumferentially spaced pumping blades in said channel forming a plurality of pumping pockets,

and a casing having two concentric pumping ducts of substantially semi-toroidal cross-section confronting said pumping blades,

one end of each of said concentric pumping ducts having a port formed therein comprising respectively an inlet and an outlet for the pump,

the opposite end of each said concentric pumping ducts being interconnected by a crossover passageway to stage said pumping ducts in interconnected flow relation, and

a cover for said crossover passageway and overlying the adjacent ends of said pumping ducts to reduce flow losses between the pumping ducts.

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