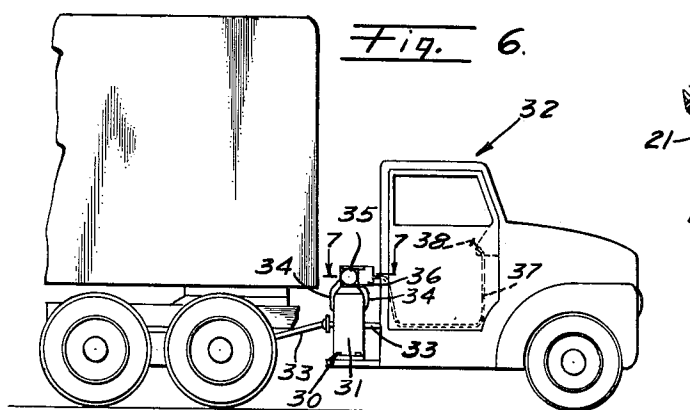
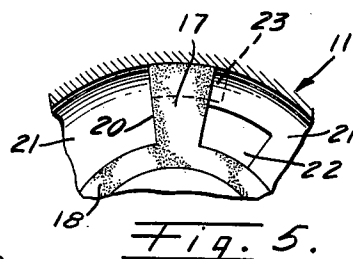
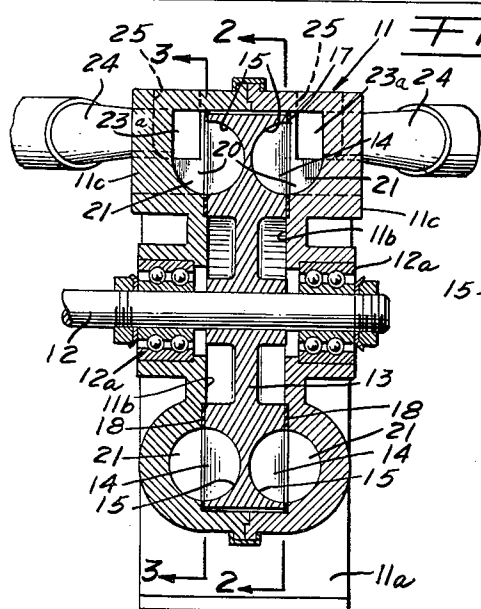
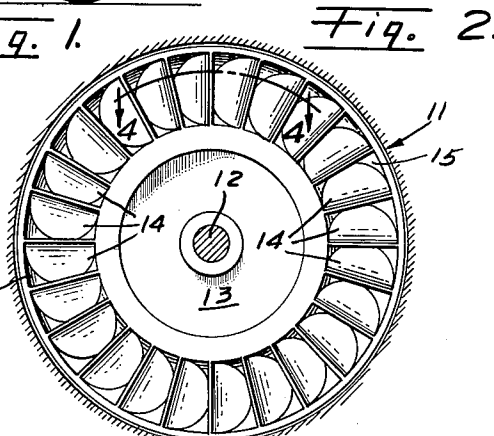
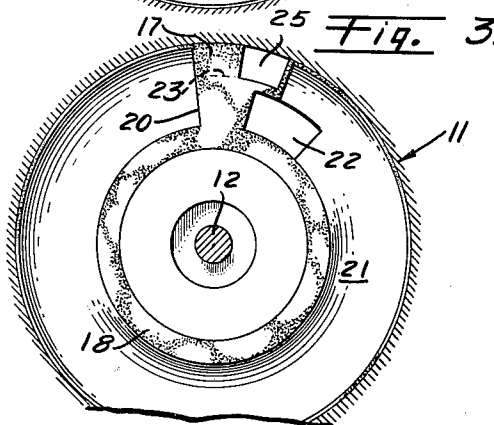
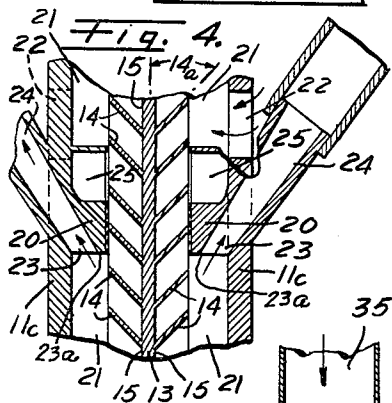
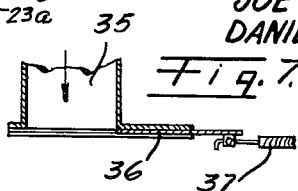


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REENTRY ROTARY FLUID PUMP

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3,095,820

REENTRY ROTARY FLUID PUMP

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Our invention relates to pumps generally known as "drag" pumps which include turbine, turbulence, regenerative, peripheral, traction, vortex, friction and reentry pumps.

Such pumps are usually a simple, single, impeller device with structural features similar to centrifugal pumps but with head-capacity characteristics approaching those of positive displacement pumps.

Our invention more particularly relates to a unique design of reentry pump in which high fluid heads may be produced at relatively low peripheral velocities with a design of relatively simple mechanical components.

It is an object of our invention to provide a pump of the class described in which secondary vortices and peripheral flow reversals are materially reduced with the result that greater kinetic energy transfer from impeller to fluid is attained.

It is another object of our invention to provide a pump of the class described having the features referred to in the preceding paragraph in which the impeller is provided with straight canted vanes located in semicircular impeller passages.

It is a still further object of our invention to obtain a superior and more efficient flow pattern by employing a unique improved porting arrangement.

It is a still further object of our invention to provide a pump of the class described in which superior pumping action is achieved by using unique flow channel and impeller configurations which promote a centrifugal reentrant flow pattern.

In using such a pump in handling air or other compressible or incompressible fluids there are present in the pump inherent losses in the pressure head developing ability of the pump. Such losses are due to the throttling expansion of gases trapped in the impeller after the vanes have passed the barrier or sealing block of the structure which separates the pump outlet from the pump inlet.

Accordingly, it is an object of the invention to provide a reentry pump of improved construction for handling air or other compressible fluids which minimizes such inherent losses in the head developing ability of the pump as those due to the throttling expansion of gases trapped in the impeller after the impeller vanes have passed the sealing block.

Another object is to provide superior inlet and exhaust porting which increases head and efficiency characteristics of the reentry pump of the invention when handling either compressible or incompressible fluids.

Numerous other objects and additional advantages of the invention will become evident from the following detailed description and drawings of preferred forms of our invention.

FIG. 1 is a sectional elevational view of an embodiment of the reentry pump taken along a plane passing through its axis of rotation and a sealing block;

FIG. 2 is a partial cross-sectional view of the embodiment of FIG. 1 taken along line 2-2 and showing the structure and arrangement of the impeller vanes;

FIG. 3 is a view similar to that of FIG. 2 but taken along line 3-3 and showing the inner surface of the casing of the pump;

FIG. 4 is a partial sectional view taken as along curved line 4-4 of FIG. 2 showing additional structural and

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arrangement features of the impeller vanes and the sealing block, and showing inlet, outlet and warm gas bleed ports;

FIG. 5 is a fragmentary view similar to that of FIG. 3 showing a sealing block and port arrangement in another embodiment of the invention;

FIG. 6 is a partial side elevational view showing a pump of the invention applied to a motor vehicle for use as a power absorber; and

FIG. 7 is a fragmentary cross-sectional view taken as along a line 7-7 of FIG. 6, drawn to a greatly enlarged scale, and showing a detail of a shut off valve.

In FIGS. 1 to 4 inclusive, we have illustrated a preferred form of a pump incorporating the features of our invention. Referring to these figures, the numeral 11 represents a pump casing which has mounting feet 11a for securing it in an operating position. The casing 11 provides an impeller chamber 11b in which an impeller 13 is rotatably supported by a shaft 12 which is in turn mounted in ball bearings 12a of the casing 11.

The impeller 13 is symmetrically formed on opposite sides of a vertical central plane and near its periphery is provided with annular semicircular impeller channels 15 in which vanes 14 are positioned. The vanes 14 extend radially with respect to the axis of rotation of the impeller 13 and are canted or inclined forwardly with respect to the direction of rotation of the impeller 13, as illustrated best in FIG. 4. The acute angle of the vane 14 with respect to the central rotational plane of the impeller 13, as indicated at 14a is between about 20 and about 70 degrees, preferably between about 30 and about 60 degrees. Especially good results have been obtained when handling air in a pump wherein the angle was between 40 and 50 degrees.

The walls 11c forming the sides of the chamber 11b provide annular semicircular flow passages 21 which are on the same diameter as the annular semicircular channels 15. The relationship between the channels 15 and flow passages 21 are illustrated best in FIG. 1. Sealing surfaces 17 and 18 are provided outwardly and inwardly respectively of channels 15 and passages 21 to seal off the two sets of channels and the two flow passages and to prevent leakage from the pump.

The casing 11 provides a sealing block 20 which defines the inlet end and the outlet end of the flow passages 21. Fluid to be pumped, whether it be liquid or gas, enters the fluid passages 21 through inlet openings 22 formed in the side walls 11c of the casing 11, and the fluid passes from the outlet ends of the passages 21 through outlets 23, as shown clearly in FIG. 4. The end of the sealing block 20 defining the outlet end of the passages 21 has a surface disposed in each passage 21 substantially in a radial plane passing through the axis of rotation of the impeller 13. The outlets 23 have openings 23a which are positioned entirely in said surfaces of the sealing block 20. Outlets 23 communicate with diffusers 24. As best shown in FIG. 4, the angle of the outlets 23 to the rotational plane of the impeller 13 is made so that the outlets are aligned with the direction of flow of fluid discharging from the impeller vanes 14 of the impeller. Thus it can be understood that by positioning the opening of the outlet entirely within a surface substantially normal to the direction of rotation of the impeller and positioning the outlet at an angle substantially in alignment with the flow of fluid as it leaves the impeller vanes, a flow path out of the pump is obtained which is in accordance with that developed within the pump, and as a result shock losses are reduced materially with a substantial increase in the efficiency of the pump. The throats of the outlets 23 are followed by diffusers 24 of increasing cross-sectional area to give maximum efficiency to the conversion of kinetic to po-

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tential energy as the fluid discharges from the pump. The outlets 23, as best shown in FIG. 3, are positioned in the outer, circumferential portion of the sealing block 20.

A feature of our invention resides in the use of warm gas bleed ports 25 formed, as best shown in FIGS. 3 and 4, through sealing block 20, and communicating with flow passages 21. Ports 25 also are positioned in the outer, circumferential portion of sealing block 20 and are sealed from inlet ports 22 to prevent mixing of warm bleed gas with inlet gas.

In the operation of a reentry pump of the type shown in FIGS. 1 to 4, the inlet fluid enters at inlet ports 22, is drawn into the impeller 13 into channels 15 between vanes 14 near the roots or inner circumferential portions thereof. While under the effect of centrifugal force, the fluid then continues in a substantially helical path between each pair of adjacent vanes 14 and into and out of flow passages 21 of casing 11 many times before it is discharged through outlet port 23. During the substantially helical traverses of the fluid mentioned above the static pressure gained in the semicircular channels 15 between a pair of vanes 14 is consumed in the flow passages 21 in forcing the fluid radially inwardly through the region of the roots or inner portions of vanes 14 for reentry into the channels 15 of impeller 13. The kinetic energy gained by the fluid is converted into potential energy in the form of static pressure in the flow passages 21 of the casing 11 by fluid deceleration. It is this latter conversion of kinetic energy which is responsible for the head rise produced in the reentry pump of the invention.

When prior art reentry pumps are used to handle gases such as air, or other compressible fluids, they suffer an inherent decrease in head developing ability. It is an important feature of the pump of our invention that this decrease in realizable pressures does not occur to such an extent as in prior art pumps when handling air or other gases or compressible fluids. We have discovered that this decrease in head developing ability is partially due to the recirculation of warm air exhaust for example, which is trapped between impeller vanes 14 by the sealing block 20. This recirculated warm air, because of its heat content, is not as compressible as the cooler charge air, or other gas. Thus, this recirculated air causes a decrease in the head developing ability or realizable pressures of the pump.

We have found that a substantial improvement in head developing ability is realized by using the warm air or gas bleed ports 25 described hereinabove. These ports purge the pump of the unavailable trapped warm or hot compressed gas and prevent recirculation thereof. In this manner the inlet ports 22 constantly reprime the channels 15 between adjacent vanes 14 with cool intake gas, which is most readily compressed, immediately after the channels have been purged of trapped warm or hot recirculating compressed gas. Thus higher pressures are developed and increased efficiencies result by the use of this feature of our invention when handling gases or compressible fluids.

The use of the straight canted vanes 14 in the pump of our invention has two important advantages over the structures used in prior art pumps. First, the kinetic energy transfer, from impeller vanes 14 to the charge fluid, is greatly increased, as in a conventional centrifugal pump utilizing an inducing inlet section and forward swept blade tips. Secondly, the use of straight canted vanes 14 materially reduces shock losses that would be encountered by the charge fluid upon entering the impeller 13.

It will be understood that the reentry pump of our invention has many varied uses and applications in situations where it is desired to transfer gases or fluids including air, gaseous hydrocarbons, water, oil, gaseous or liquid chemicals, or fluid mixtures of gases and liquids. Reentry pumps of our invention have been used to supply

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scavenge air for separately charged two-stroke engines, to supply air to turbosuperchargers, as liquid pumps, and for drag turbines. Many additional miscellaneous uses for the reentry pump of our invention will present themselves to persons engaged in the various engineering fields.

In some applications, the warm or hot gas bleeds 25 are not required and can be left out of the structure. In such cases the pump will resemble the structure shown in FIG. 5, which is a view showing the sealing block 20 region and the inlet port 22 and outlet port 23. The structure shown in FIG. 5 can conveniently be used in handling liquids or in cases where the entrapment of warm gases in the manner described hereinabove is not a serious factor.

An example of an interesting application of the reentry pump of our invention, described above in connection with FIGS. 1 to 4, is shown in FIGS. 6 and 7, wherein the pump is used as a power absorber or retarder, indicated in the illustrated assembly at 30.

This retarder has the same basic internal structure as the reentry pump, shown in FIGS. 1-4 and has a generally typical circular casing 31. In FIG. 6, the casing 31 is shown to be secured against rotation to the frame or other parts of a truck 32. In this embodiment the drive shaft 33 of the truck replaces the typical pump shaft 12. An additional set of gears (not shown) can be added to the retarder to increase its speed above that of the drive shaft 33. The impeller, which may be identical with impeller 13 in FIGS. 1-4, is in continuous rotation when the drive shaft 33 is rotating and causing the truck to move. Also, a clutch (not shown) can be added to the retarder installation for engagement and disengagement with the truck's drive shaft. When no retardation is desired, the clutch is disengaged.

The retarder 30 may have typical diffusers 34 from each side thereof equivalent to the diffusers 24 which are connected to the pump discharges 23. The diffusers 34 are shown to join in a common outlet 35 on which is schematically attached the gate-type shut off valve 36, shown in detail in FIG. 7. This valve may be operated by flexible cable 37 which terminates in the truck cabin at handle or knob 38. In addition, the retarder may be equipped with a vacuum pump (not shown) and an inlet shut off valve to minimize energy absorption when not desired.

In operation, when the truck is moving in a normal way on level ground or going up an incline, the valve 36 is wide open so that no pressure builds up within the retarder 30. However, when the truck starts down an incline, the operator, to make use of the retarder, will close the valve 36 the desired amount so as to hold back the movement of the truck. In this embodiment, a hot air exhaust (not shown), similar to exhaust 25 in FIG. 4, may also be provided. Thus pump 11, shown in FIGS. 1-4 may be used as a reentry compressor to absorb the power caused by the weight of the truck going downhill by compressing atmospheric air, a noncaptive media, when the valve 36 is closed or partially closed. This, of course, will decrease the speed of the truck.

It has been found that a retarder, according to the present invention, will absorb higher horsepower rates for a given weight size than any other system currently in use in this country or Europe. It also provides surge-free power absorption at modest speeds due to the unique inherent characteristics of the reentry compressor. Test data indicates that the power absorption range can be easily 6 to 1 at a specified speed.

Such a retarder is extremely simple so as to have maximum reliability, a low maintenance cost, a low initial cost and be relatively lightweight. Another advantage of the present retarder is that it is inherently an antiskid device because the power absorption is reduced by the cube of the speed reduction. This, of course, is especially advantageous when operating on roads coated with ice.

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A further advantage is that the basic capacity of the retarder is not limited by the vehicle's radiator capacity as are some retarders in the prior art since the heat energy is ejected directly to the atmospheric air.

It may be readily seen from the foregoing that the simple structure provided in the reentry pump, according to the present invention, may be used with equal facility for pumping gases or liquids and may be used in a novel combination as a power absorber on heavy motor vehicles to thereby add considerable safety to the highways and increased revenue to truck operators.

We claim:

1. In a reentry rotary fluid pump: a casing; an impeller mounted for rotation in said casing; a plurality of spaced vanes disposed on said impeller at a common radius from the center of the rotational axis of said impeller, said vanes extending outwardly from said impeller; a flow passage in said casing laterally outwardly of said vanes and in communication therewith; an inlet into said casing and into said flow passage; a discharge passage from said flow passage outwardly through said casing; a sealing block in said casing outwardly of said vanes providing a seal between said inlet into said flow passage and said discharge from said flow passage; and a fluid bleed port adjacent the sealing block open through the casing to the vanes adjacent the outer portion of said flow passage for preventing recirculation of trapped fluid in the flow passage.

2. In a reentry rotary fluid pump: an annular-shaped casing; a circular impeller mounted for rotation in said casing; a plurality of circumferentially spaced vanes extending outwardly from said impeller adjacent the circumference thereof; a substantially circumferential flow passage in said casing and extending immediately laterally outwardly of said vanes and being in communication therewith; a bucket formed between each two of said vanes, the inner surface of said buckets extending between each of said vanes being complementary to the surface of said flow passage outwardly therefrom so that when the impeller is rotated, fluid in said buckets will repeatedly circulate from the radially inner portion thereof in relation to the axis toward the radially outer portion thereof away from said axis and into the radially outer portion of said flow passage toward the radially inner portion of said flow passage; a sealing block in said casing forming two ends of said flow passage; a fluid inlet through said casing into said flow passage adjacent a side of said sealing block toward the direction of rotation; a fluid discharge on the other side of and through said sealing block connecting said flow passage and the exterior of said casing, said fluid inlet being in the radially inner portion of said flow passage to cause fluid to enter the radially inner portion of said buckets on said impeller, said fluid discharge being in a radially outer portion of said sealing block in alignment with the radially outer portions of said flow passage and said vanes; and a warm gas exhaust extending outwardly through the sealing block adjacent the inlet side thereof and outwardly through said casing, said warm gas exhaust being in the radially outer portion of said sealing block and being radially outwardly of said inlet.

3. In a reentry rotary fluid pump: a generally circular casing; a circular impeller mounted for rotation within said casing; a plurality of circumferentially spaced vanes extending outwardly from said impeller adjacent the circumference thereof and from at least one side of said impeller generally toward the direction of rotation and at an acute angle with the axis of rotation, each two of said vanes forming a bucket in the space therebetween, each of said buckets having plane side surfaces formed by said vanes and having a generally semicircular outwardly opening concave inner surface; a substantially annular flow passage in said casing extending immediately laterally outwardly of said vanes and being in communication therewith, said flow passage having a generally semi-

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circular cross section and opening inwardly toward said vanes so that a plane through said axis of rotation and through said flow passage and said impeller vanes will cut a generally circular cross section half of which is formed by said flow passage and the other half of which is formed by said buckets between said vanes; a sealing block in said casing and forming two adjacent ends of said flow passage immediately outwardly of said impeller vanes; an inlet into said flow passage from the exterior of said casing on the side of said sealing block toward the direction of rotation and directed toward a portion of said vanes; a discharge outlet from said flow passage on the other side of said sealing block through said sealing block and said casing, said inlet being in the inner circumferential portion of said annular flow passage and said discharge outlet being in the outer circumferential portion of said annular flow passage; and a warm gas exhaust extending outwardly through said sealing block adjacent the inlet side thereof and extending outwardly through said casing, said exhaust being in the radially outer portion of said sealing block and being radially outwardly of said inlet, a portion of said inlet in said casing being advanced in the direction of rotation relative to said warm gas exhaust.

4. In a reentry rotary fluid pump: a generally circular casing; a circular impeller mounted for rotation within said casing; a plurality of circumferentially spaced vanes extending outwardly from said impeller adjacent the circumference thereof and from at least one side of said impeller generally toward the direction of rotation and at an acute angle with the axis of rotation, each two of said vanes forming a bucket in the space therebetween, each of said buckets having plane side surfaces formed by said vanes and having a generally semicircular outwardly opening concave inner surface; a substantially annular flow passage in said casing extending immediately laterally outwardly of said vanes and being in communication therewith, said flow passage having a generally semicircular cross section and opening inwardly toward said vanes so that a plane through said axis of rotation and through said flow passage and said impeller vanes will cut a generally circular cross section half of which is formed by said flow passage and the other half of which is formed by said buckets between said vanes; a sealing block in said casing and forming two adjacent ends of said flow passage immediately outwardly of said impeller vanes; an inlet into said flow passage from the exterior of said casing on the side of said sealing block toward the direction of rotation and directed toward a portion of said vanes; a discharge outlet from said flow passage on the other side of said sealing block through said sealing block and said casing, said inlet being in the inner circumferential portion of said annular flow passage and said discharge outlet being in the outer circumferential portion of said annular flow passage; and a warm gas exhaust extending outwardly through said sealing block adjacent the inlet side thereof and extending outwardly through said casing, said exhaust being in the radially outer portion of said sealing block and being radially outwardly of said inlet, the direction of said discharge into said sealing block substantially following the direction of rotation of said impeller and the direction of the angles of said vanes.

5. For use as a retarder for a motor vehicle, a reentry rotary gas pump comprising: an annular-shaped casing; a circular impeller fitted for rotation in said casing and adapted to be mounted for rotation on the drive shaft of a motor vehicle; a plurality of circumferentially spaced vanes extending outwardly from said impeller adjacent the circumference thereof; a substantially circumferential gas flow passage in said casing and extending immediately laterally outwardly of said vanes and being in communication therewith; a bucket formed between each two of said vanes, the inner surface of said buckets extending between said vanes being complementary to the surface of

said flow passage outwardly therefrom so that when the impeller is rotated, gas in said buckets will repeatedly circulate from the radially inner portion thereof in relation to the impeller axis toward the radially outer portion thereof away from said axis and into the radially outer portion of said flow passage toward the radially inner portion of said flow passage; a sealing block in said casing forming two ends of said flow passage; a gas inlet through said casing into said flow passage adjacent a side of said sealing block toward the direction of rotation; a gas discharge on the other side of and through said sealing block connecting said flow passage and the exterior of said casing, said gas inlet being in the radially inner portion of said flow passage to cause gas to enter the radially inner portion of said buckets on said impeller, said gas discharge being in a radially outer portion of said sealing block in alignment with the radially outer portion of said flow passage and said vanes; and a warm gas exhaust extending laterally outwardly through said sealing block adjacent the inlet side thereof and extending outwardly through said casing, said exhaust being in the radially outer portion of said sealing block and being radially outwardly of said inlet.

6. For use as a retarder for a motor vehicle, a reentry rotary gas pump comprising: an annular-shaped casing; a circular impeller fitted for rotation in said casing and adapted to be mounted for rotation on the drive shaft of a motor vehicle; a plurality of circumferentially spaced vanes extending outwardly from said impeller adjacent the circumference thereof; a substantially circumferential gas flow passage in said casing and extending immediately laterally outwardly of said vanes and being in communication therewith; a bucket formed between each two of said vanes, the inner surface of said buckets extending between said vanes being complementary to the surface of said flow passage outwardly therefrom so that when the impeller is rotated, gas in said buckets will repeatedly circulate from the radially inner portion thereof in relation to the impeller axis toward the radially outer portion thereof away from said axis and into the radially outer portion of said flow passage toward the radially inner portion of said flow passage; a sealing block in said casing forming two ends of said flow passage; a gas inlet through said casing into said flow passage adjacent a side of said sealing block toward the direction of rotation; a gas discharge on the other side of and through said sealing block connecting said flow passage and the exterior of said casing, said gas inlet being in the radially inner portion of said flow passage to cause gas to enter the radially inner portion of said buckets on said impeller, said gas discharge being in a radially outer portion of said sealing block in alignment with the radially outer portion of said flow passage and said vanes; and a warm gas exhaust extending laterally outwardly through said sealing block adjacent the inlet side thereof and extending outwardly through said casing, said exhaust being in the radially outer portion of said sealing block and being radially outwardly of said inlet, a portion of said inlet in said casing being advanced in the direction of rotation relative to said warm gas exhaust.

7. For use as a retarder for a motor vehicle, a reentry rotary gas pump comprising: a casing; an impeller fitted for rotation in said casing and adapted to be mounted for rotation on the drive shaft of a motor vehicle; a plurality of spaced vanes disposed on said impeller at a common radius from the center of the rotational axis of said impeller, said vanes extending outwardly from said impeller; a gas flow passage in said casing laterally outwardly of said vanes and in communication therewith; a gas inlet into said casing and into said flow passage; a gas discharge passage from said flow passage outwardly through said casing; a sealing block in said casing outwardly of said vanes providing a seal between said inlet to said flow passage and said discharge from said flow passage; and a gas bleed port adjacent the sealing block and

open through the casing to the vanes adjacent the outer portion of said flow passage for preventing recirculation of trapped gas in the flow passage.

8. In a reentry rotary fluid pump: a generally circular casing; a circular impeller mounted for rotation within said casing; a plurality of circumferentially spaced vanes extending outwardly from said impeller adjacent the circumference thereof from at least one side of said impeller generally toward the direction of rotation and at an acute angle with the axis of rotation, each two of said vanes forming a bucket in the space therebetween, each of said buckets having plane side surfaces formed by said vanes and having a generally semicircular outwardly opening concave inner surface; a substantially annular flow passage in said casing extending immediately laterally outwardly of said vanes and being in communication therewith, said flow passage having a generally semicircular cross section and opening inwardly toward said vanes so that a plane through said axis of rotation and through said flow passage and said impeller vanes will cut a generally circular cross section half of which is formed by said flow passage and the other half of which is formed by said buckets between said vanes; a sealing block in said casing having opposite ends and forming two ends of said flow passage immediately outwardly of said impeller vanes; an inlet into said flow passage from the exterior of said casing adjacent the end of said sealing block toward the direction of rotation and directed toward a portion of said vanes; and a discharge outlet from said flow passage in said sealing block adjacent the other end of said sealing block; said other end of said sealing block having a surface lying substantially in a radial plane through the rotational axis of said impeller, said discharge outlet having an opening disposed entirely in said surface, said discharge outlet extending from said opening outwardly through said sealing block and said casing at an angle in the direction of rotation of said impeller, said inlet being in the inner circumferential portion of said annular flow passage and said discharge outlet being in the outer circumferential portion of said annular flow passage.

9. For use as a retarder for a motor vehicle, a reentry rotary gas pump comprising: an annular-shaped casing; a circular impeller fitted for rotation in said casing and adapted to be mounted for rotation on the drive shaft of a motor vehicle; a plurality of circumferentially spaced vanes extending outwardly from said impeller adjacent the circumference thereof; a substantially circumferential gas flow passage in said casing and extending immediately laterally outwardly of said vanes and being in communication therewith; a bucket formed between each two of said vanes, the inner surface of said buckets extending between said vanes being complementary to the surface of said flow passage outwardly therefrom so that when the impeller is rotated, gas in said buckets will repeatedly circulate from the radially inner portion thereof in relation to the impeller axis toward the radially outer portion thereof away from said axis and into the radially outer portion of said flow passage toward the radially inner portion of said flow passage; a sealing block in said casing having two opposite ends forming two ends of said flow passage; a gas inlet through said casing into said flow passage adjacent one end of and on a side of said sealing block and a gas discharge outlet in said sealing block adjacent the other end of said sealing block; said other end of said sealing block having a surface lying substantially in a radial plane through the rotational axis of said impeller, said gas discharge outlet having an opening disposed entirely in said surface, said gas discharge outlet extending from said opening outwardly through said sealing block and said casing at an angle in the direction of rotation of said impeller, said gas inlet being in the radially inner portion of said flow passage to cause gas to enter the radially inner portion of said buckets on said impeller, said gas discharge outlet being in a radially outer

portion of said sealing block in alignment with the radially outer portion of said flow passage and said vanes.

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