Feb. 1, 1949. G. RATHMAN 2,460,310

SCREW PUMP

Filed Nov. 20, 1943 2 Sheets-Sheet 1

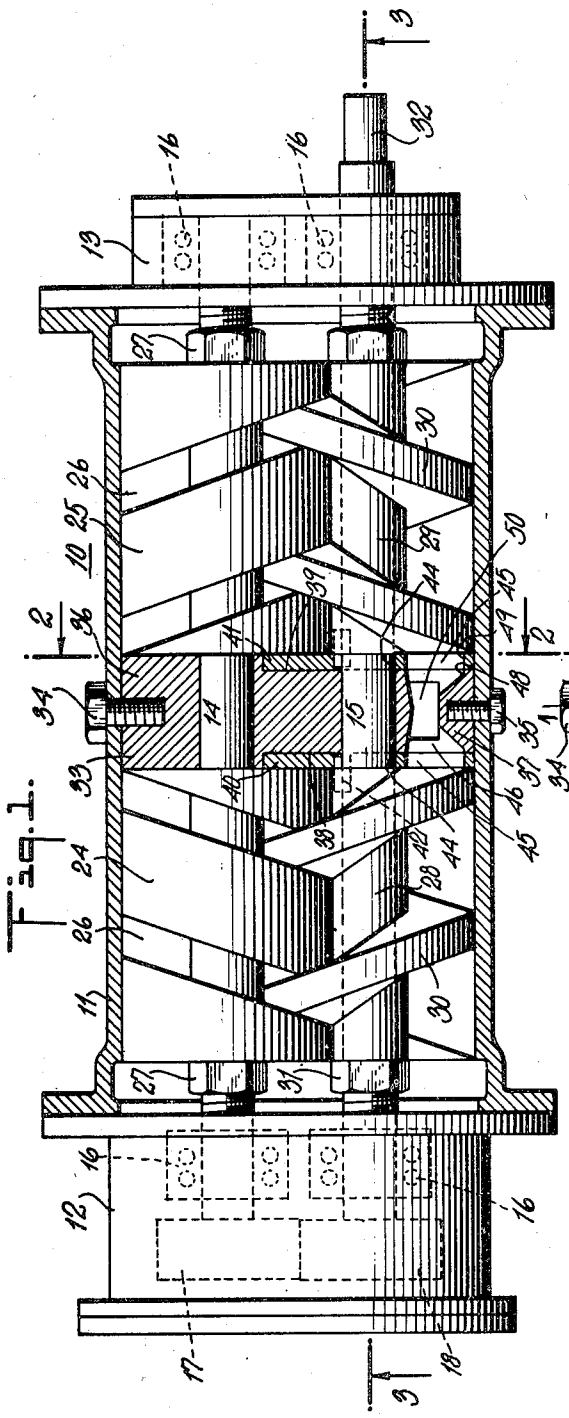


Fig. 1.

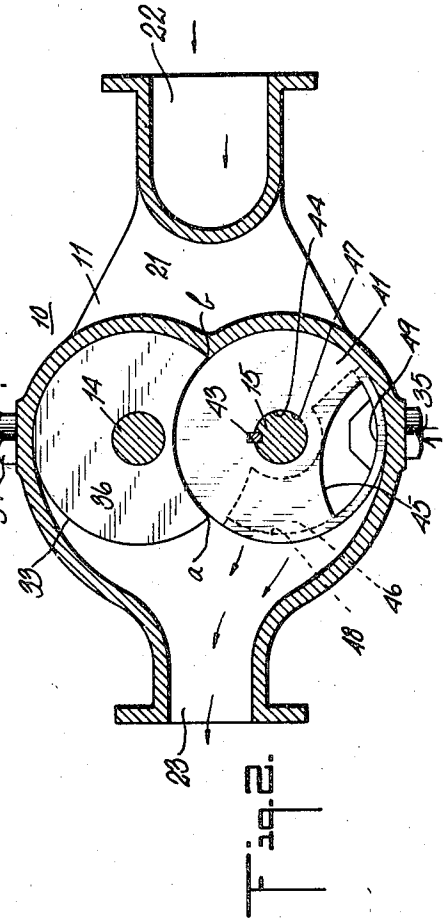


Fig. 2.

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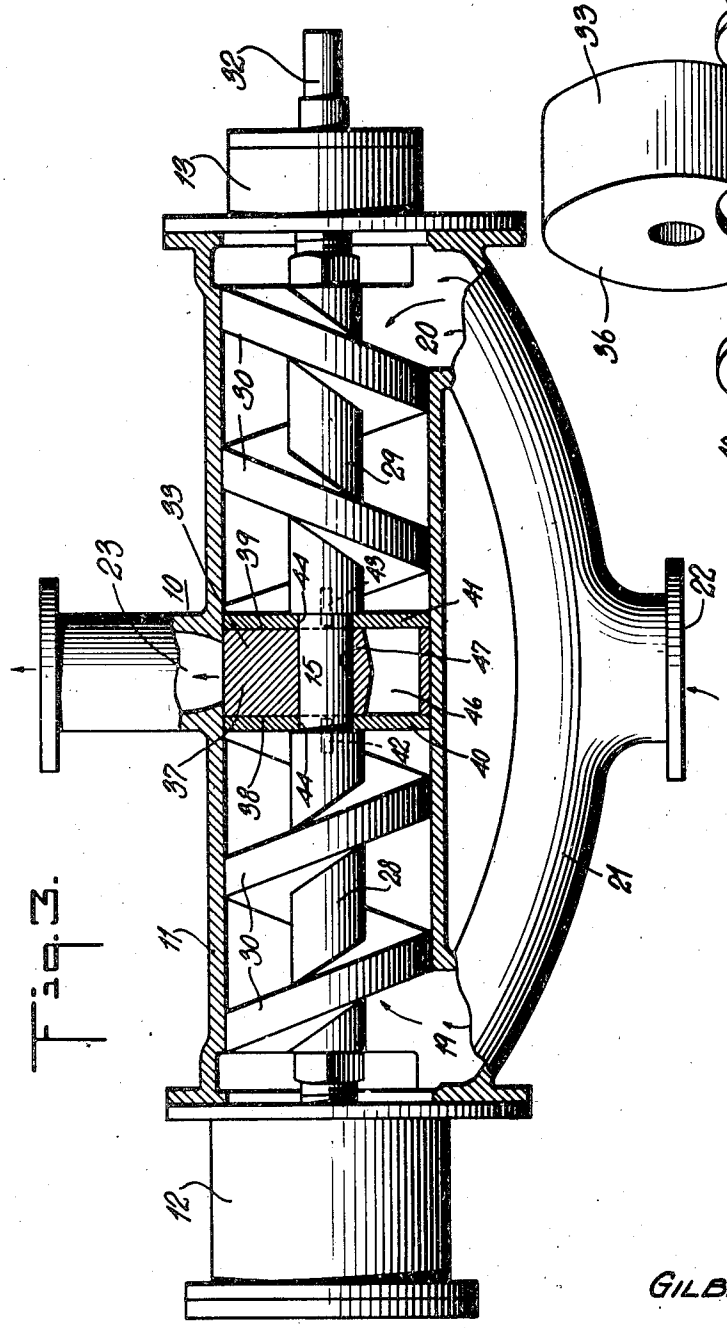


Fig. 3.

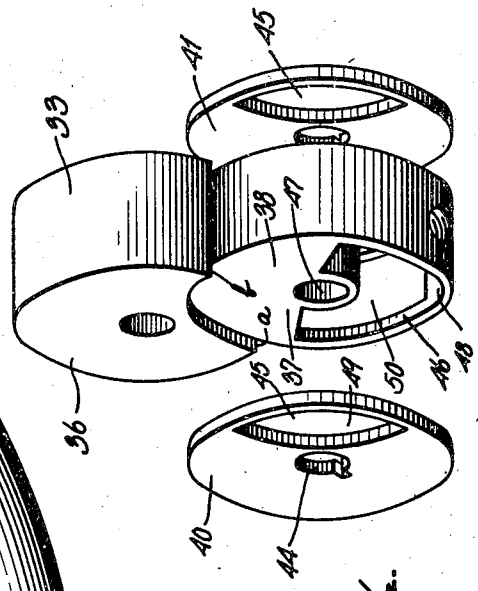


Fig. 4.

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SCREW PUMP

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9 Claims. (Cl. 230—143)

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The invention relates in general to an apparatus for propelling, or for being propelled by a compressible or expansible medium and, specifically, relates to an improved technic in the operation of displacement apparatus of the type which includes two helically ribbed rotors in meshed engagement for compressing air or gas as it flows through a conduit. In such air compressors as are now known, the low pressure air is caught at the intake end of the intermeshed rotors, is advanced along the same to the opposite ends where a reduction in cross sectional area of the groove, or grooves as the case may be, places the air under compressison at its point of discharge from the rotors. It has been found in actual practice with such air compressors that the air is discharged not in a continuous stream but periodically surging, or pulsating, back and forth in the discharge conduit.

The primary object of the invention is to provide a gaseous fluid conducting or compression pump capable of maintaining a constant flow of the gaseous medium without this objectionable surging or variable pressure condition at the discharge end of the pump and more broadly considered the invention features a method for handling the compressed air or other gaseous bodies as they are discharged from such a pump in such way as will avoid such objectionable surging and maintain the desired continuity of flow.

Broadly, this objective is attained by positioning at the discharge end or ends of the rotors a valve operatively related to the rotors to maintain the air groove or grooves closed up to the point where the maximum compression is reached or almost reached and then to automatically open the discharge end of the groove or grooves to the discharge port of the apparatus so that at each rotation of the rotors the air will be discharged at or adjacent its point of maximum compression.

Considering the situation where the apparatus is used as a prime mover such, for instance, as where it is used as a steam turbine with high pressure steam admitted to the port which in the air compressor constituted the discharge port; or where the device is used with power provided by an expanding gas as in the case of an internal combustion engine, the primary object of the invention is to provide a simple form of apparatus for translating the expansive force of the actuating medium into rotative mechanical force with a high degree of efficiency.

Various other objects and advantages of the invention will be in part obvious from an inspection of the accompanying drawings and in part will be more fully set forth in the following particular description of one form of mechanism embodying the invention, and the invention also consists in certain new and novel features of construction and combination of parts hereinafter set forth and claimed.

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In the accompanying drawings:

Fig. 1 is a view partly in side elevation and partly in vertical section taken on the longitudinal plane indicated by the line 1—1 of Fig. 2 through the rotor casing of a preferred embodiment of the invention with the rotors in position to bring the double rotary valves in open positions;

Fig. 2 is a transverse sectional view taken on the plane indicated by the line 2—2 of Fig. 1 and looking in the direction indicated by the arrows;

Fig. 3 is a horizontal sectional view taken on the plane indicated by the line 3—3 of Fig. 1 looking in the direction indicated by the arrows when the rotors have advanced the passageways in the valves to a closed position; and

Fig. 4 is an exploded view in perspective showing details of the double rotary disc valve demounted from the shafts.

In the drawings there is disclosed air pumping apparatus 10 comprising a rotor containing casing 11 having at one end a gear box 12 and at the opposite end an antifriction bearing box 13. Mounted in the apparatus are two shafts 14 and 15 disposed in parallel relation having antifriction bearings 16 at opposite ends of each shaft and with the shafts connected by a pair of gears 17—18 in gear box 12 to drive one shaft from the other. The casing 11 is provided adjacent opposite ends with inlet ports 19 and 20 which may be supplied from a manifold 21 having a single intake port 22. The casing is provided at its center and on the side opposite the ports 19 and 20 with a discharge port 23, as more particularly shown in Fig. 3.

The shaft 14 is provided with a pair of rotors 24 and 25 each provided with a helical groove 26 and keyed to the shaft and secured against outward endwise movement by nuts 27. Similarly, the shaft 15 is provided with a pair of rotors 28 and 29 keyed to the shaft and each provided with a helical rib 30 and similarly held against outward movement by nuts 31. Each of the rotors of one shaft is in intermeshed engagement with its companion rotor of the other shaft and the rotors follow conventional practices in this respect.

Shaft 15 projects to the outside of the appa-

ratus and constitutes either a driving or a driven shaft 32 depending upon the operation of the device as hereinafter described. Fitted between the inner ends of the four rotors adjacent the center of the casing 11 is a rugged casting 33 forming a spacer block secured to the casing by screws 34 and 35. This block partition is in the form of two flat cylinders 36 and 37, one partially overlapping the other and forming in effect an 8-shaped internal brace for the midlength portion of the casing. The spacer block provides a centrally positioned bearing for the two shafts 14 and 15 passed therethrough as shown in Fig. 1.

Opposite sides of the block in the portion 37 thereof which faces the helical ribs 30 are recessed to form disc-like bearings 38 and 39 of flat circular form. The adjacent ends of the rotors 28 and 29 are provided with disc-like flanges, or heads, 40 and 41 which fit in their respective bearings 38 and 39 and are keyed to the shaft respectively by keys 42 and 43. Each disc-like flange 40 and 41 is provided in the portion thereof exteriorly of its shaft receiving hole 44 with an opening 45 extending therethrough. In order to obtain maximum time delay in which the valve is open, the opening 45 is illustrated as being of an elliptical form and in its length dimension is less than the length of the arc *a*—*b* formed at the bottom of the closure cylinder 36.

The cylinder 37 is provided in the portion faced by the bearings 38 and 39 with a passageway 46 extending therethrough in offset relation to the opening 47 which receives the shaft 15. This transverse passageway extends circumferentially and in the instant case for a distance of about 165° with its outer edge 48 aligned with the outer edge 49 of the opening 45, when the openings 45 and 46 are in registration as shown in Fig. 2. The cylinder 37 is provided in the side thereof facing the outlet 23 with a passageway 50.

In operation and assuming that air is being admitted through the intake ports 19 and 20 and that the rotors are being driven from a source of power supplied through the shaft 32 and in a direction to turn their ribs towards the center, it will be understood that air admitted to the grooves 26 will be advanced by the ribs 30 towards the center of the apparatus. As the channels 26 taper in cross sectional area at their discharge ends, the air trapped therein is placed under pressure at least momentarily. It is noted that the discharge ends of the helical grooves 26 in both of the rotors 24 and 25; that is the ends where the air is finally compressed, are never open directly to the outlet valves and thus are never open to the outside air. If this were not so and air accumulating in the discharge ends of the grooves 26 in rotors 24 and 25 were permitted to escape a back pressure would develop in the grooves of the rotors 25 and 24. The air compressed in the terminal portions of the grooves 26 in both of the rotors 24 and 25 is discharged respectively into the channels of the associated rotors 28 and 29 so that the air at the discharge ends of both pairs of intergeared rotors reach their point of maximum compression at the same time. It is from the discharge ends of the channels of the rotors 28 and 29 that the air compressed in the rotors 24 and 25 is eventually and periodically discharged as herein featured. It will be understood that at this time, that is, just prior to the point at which the air reaches its maximum compression, the rotary valves are in their closed position as shown in Fig. 3. During the time while the valves interrupt the discharge flow, of course no air can escape from the compression chamber found at the discharge ends of the rotors 28 and 29. The passageway 45 is so located relative to the discharge end of the grooves or channels 26 that the passageway 45 is brought into registry with the passageway 46 as the air reaches its point of maximum compression as the result of the compressive action of all four rotors. The air so compressed is passed through passageways 46 and 50 and moves through the outlet 23 as indicated by the arrows in Fig. 2.

It has been found that this method of delaying the escape of the air until it reaches or at least approaches its point of maximum compression, and then releasing it at this point, has the effect of avoiding the surging, or pulsating action, which takes place in devices of this character where such a periodically opening and closing valve so timed in its action is not used.

Considering the use of the apparatus where a flowing or expanding gas is utilized to rotate the shaft 32 as in those cases where the port 23 is connected with the firing chamber of an internal combustion engine supplied with a carburetor, the gases are periodically admitted to the inner ends of the rotors and in expanding react on the helical ribs 30 to rotate the rotors and in this way drive the shaft 32. It is understood, of course, that in this case the port 22 constitutes an exhaust for the expanded gases.

I claim:

1. In a device of the class described, the combination of a rotor casing having inlets adjacent its opposite ends and an outlet adjacent its center, two parallel shafts journalled in tht casing, means for driving one shaft from the other, each shaft provided with a pair of helically ribbed rotors fitted in the casing and with each of the rotors of one shaft in intermeshed engagement with its companion rotor on the other shaft, a spacing block secured to the casing providing a rugged internal brace for the same and fitting between the rotors of one shaft to limit their approach towards each other and to provide a wall defining and closing the adjacent ends of the channels of said one shaft, and coacting with the adjacent ends of the channels thereof to form on each side of the spacing block a pair of tapered air compressing spaces, each pair of compression spaces being open at all times to the discharge end of the groove in its associated rotor of the other shaft, the inner ends of the rotors of the other shaft each provided with an outstanding flange in rotative sliding engagement with the adjacent side of the block, each flange provided with a slot extending therethrough and in open communication with the groove in its associated rotor and a channeled block secured to the casing at the outlet, fitted between the flanges and provided with a passageway leading to the outlet from the sides thereof adjacent the flanges said slots being each of less circumferential length than that of the passageway whereby the passageway is closed once for each rotation of the flanges, the slots in each flange registering with the said passageway, once for each rotation of the flanges and said flanges and channeled block coacting to form a double valve of the rotary disc type.

2. In a device of the class described, the combination of a casing having an outlet port at its midlength and a pair of inlet ports adjacent opposite ends, a gear box at one end and a bearing box at the other end of the casing, a pair of par-

allel shafts extending through the casing and journalled in the bearing box and gear box, a gear train in the gear box connecting the shafts, an 8-shaped block secured to the casing at its midlength and through which the smooth mid-portion of the shafts extend, each shaft provided on opposite sides of the block with a helical rib, with the rib on one shaft meshing into the helical groove of the adjacent rib of the other shaft, opposite sides of the block in the area surrounding one of the shafts recessed to provide bearings of flat circular form, said last named shaft having keyed thereto a pair of disk-like flanges, one for each bearing and rotatably fitted therein, said block having in each of the sides provided with the bearings an arc-shaped opening, each flange provided with the portion thereof exteriorly of its associated shaft with an opening of less arc length than the arc length of the opening in the block and of approximate elliptical form, and said block provided with a passageway open at one end to the outlet port, and the other end of the passageway being alternately opened and closed from the two pairs of meshed helical ribs by the rotation of said shaft and its associated flanges.

3. In a device for moving a fluid, the combination of a housing having at least two openings therein, one forming an inlet and the other forming an outlet for the fluid, and a pair of intermeshing and cooperating screwlike rotors in said housing coacting to pass the fluid through the housing from the inlet through the outlet, a partition in the form of an 8-shaped casting fitted in the casing and located between one of the openings and the adjacent ends of the pair of rotors, said partition provided with an opening having a dimension considered circumferentially materially less than 180° and facing one of the rotors and said partition in the area thereof facing the other rotor being imperforated and thus acting at all times to close the channel at the adjacent end of the other rotor, the ends of the channels of both rotors coacting with the partition to form compartments tapering in cross sectional area to permit the fluid to expand or to become compressed as it passes therethrough, depending on the direction of movement of the fluid therethrough, with said compartments being at all times in intercommunication, and one of said compartments periodically exposed through said opening to the outlet during a portion of each rotation of the rotors.

4. In a device of the class described, the combination of a casing provided with inlet and outlet ports, a pair of rotors located between the ports, means connecting the rotors to drive one from the other, the rotors provided with coacting ribs in interengaging relation to compress fluid in the grooves of both rotors as the fluid reaches the discharge ends of the grooves, one of the rotors constituting a driving rotor and the other a driven rotor, an element fixed to the casing and forming a stop engaged by the adjacent ends of both rotors, said element provided with a conduit leading to the discharge port and the intake end of said conduit forming an opening facing the adjacent end of the driving rotor and confined to the space within the axially projected cross sectional area of said driving rotor, said driving rotor and opening related to periodically open the adjacent end of the groove in the driving rotor once for a part of each rotation of the same, and said element extending solidly in overlapping relation to the adjacent end of the driven rotor to close the adjacent end of its groove and thus intercept direct fluid communication between the outlet port and the groove in said driven rotor while permitting the air compressed in the groove of the driven rotor to by-pass therefrom into the groove of the driving rotor from which it is discharged through said opening when the discharge end of the groove in the driving element registers with said opening.

5. A fluid propelling pump comprising pumping mechanism having its elements duplicated in balanced relation on opposite sides of a transverse medial plane and comprising on each side of the plane two helically ribbed rotatable elements in intermeshing engagement and adapted to advance a fluid there-through, and to place it under compression, said elements intergeared to drive one from the other, a casing surrounding said elements and provided with an inlet for the fluid open to the receiving ends of said elements and an outlet adjacent their opposite or discharging ends, two of the elements, one on each side of the medial plane provided at their opposite or fluid discharging ends each with a head, a block located between said heads and the outlet, located in said transverse plane and forming a barrier for the adjacent ends of the other two elements on opposite sides of the medial plane, said block and head provided with means coacting to form a valve of the rotary disc type, said block and head being each provided with passage-ways extending there-through and adapted as each head is rotated with its associated ribbed element to register with the passage-way through the block to discharge the fluid advanced between the four ribbed elements periodically once for each rotation of the elements.

6. In a device of the class described, the combination of the casing provided with inlet and outlet ports, a pair of intermeshing helically ribbed rotors for advancing fluid from the inlet to the outlet ports and for placing the fluid under pressure as it is discharged, an element fixed relative to the casing, provided with an opening facing the discharge high pressure end of one of the rotors, and confined to the space within the axially projected cross sectional area of said rotor and said element acting as a barrier for closing the discharge end of the other rotor, said first named rotor and its associated opening being related to open the adjacent end of the first named rotor periodically once for each rotation of the same and only at that point where the rotors reach their point of maximum compression.

7. A screw pump including a casing having inlet and outlet ports, a pair of rotors journalled in the casing and intergeared to drive one from the other, each rotor provided with a spiral ribbed part, with one of said spiral ribbed parts intermeshing with the other to force fluids from the inlet through the casing and out through the outlet and to place them under compression at the discharge ends of said spiral ribbed parts, a member fixed relative to the casing, extending across the interior of the same and located between the discharge ends of the spiral ribbed parts of the rotors and the outlet, said member provided with a passage-way facing the discharge end of one of said spiral rib parts, confined to the axially projected cross section of the spiral ribbed part which it faces, said passage-way arc-

shaped in cross section, and another portion of said member extending entirely across the axially projected cross section of the other spiral ribbed part and forming a barrier, to defeat transference of the fluid from the discharge end of said other spiral ribbed part directly into the outlet.

8. In a device of the class described, the combination of a casing provided with inlet ports at opposite ends thereof and a discharge port adjacent its mid-length, a pair of rotors journalled in the casing, means for driving one rotor from the other, each rotor provided with two helically ribbed portions disposed on opposite sides of the mid-length of the casing, a partition fitted in the casing for closing the inner ends of both of said helically ribbed portions to cause the inner ends of all of the channels in said helically ribbed portions to be of reduced cross sectional area towards the partition, said partition provided with a passage-way leading to the discharge port and adapted to receive fluids discharged from the inner ends of the helically ribbed portions of one of the rotors, the discharge ends of all channels being otherwise closed.

9. In a device of the class described, the combination of a casing provided with an inlet port and an outlet port, a pair of intermeshing screws fitted for free rotary movement in the casing and coacting to advance a fluid from the inlet port through the casing and out through the outlet port, means for driving one screw from the other at a one-to-one ratio, a partition fixed in the

casing against movement axially of the screws and against which the discharge ends of both screws abut, the opposite or intake ends of the screws being wide open to the inlet port, said partition forming a barrier to close completely the discharge end of one of the screws and means controlled by the rotation of the other screw for opening communication between the discharge end of the said other screw and the outlet port once for each rotation of the screws.

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