April 13, 1948. A. A. MERCER 2,439,668

PUMP OR COMPRESSOR

Filed April 3, 1944 3 Sheets-Sheet 1

FIG. 1.

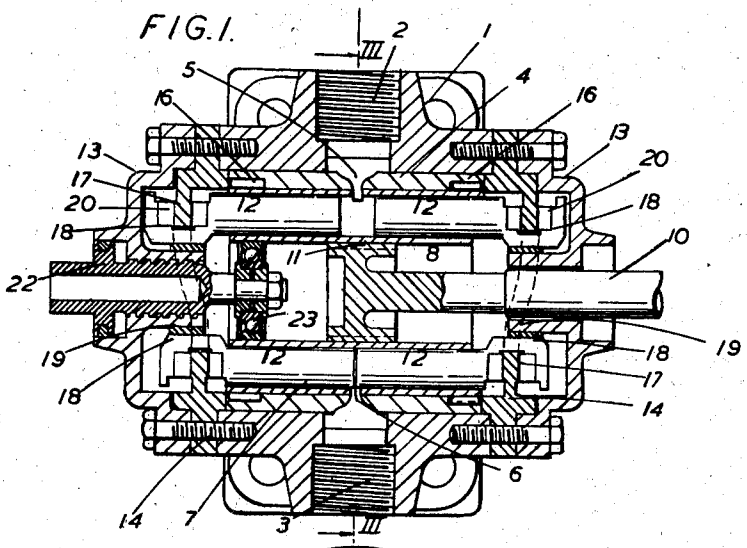



FIG. 2.

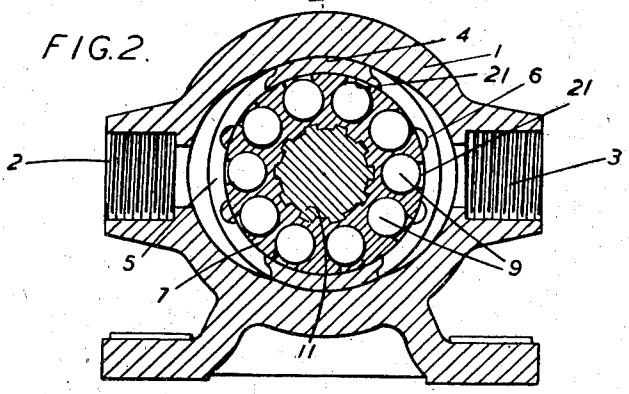
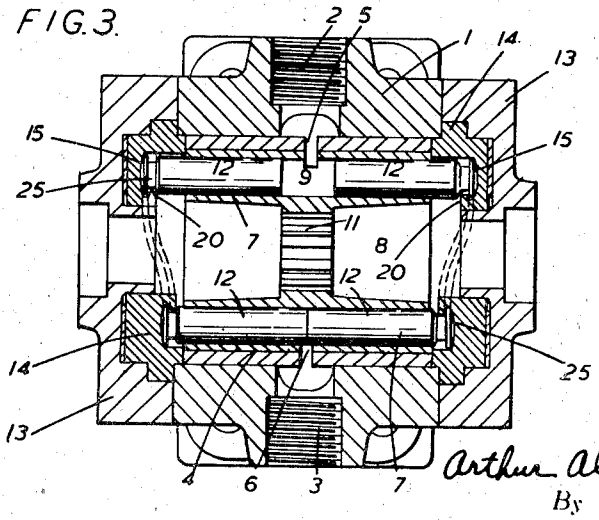



FIG. 3.




Inventor
Arthur Alexander Mercer
By John B. Brady
Attorney

April 13, 1948. A. A. MERCER 2,439,668

PUMP OR COMPRESSOR

Filed April 3, 1944 3 Sheets-Sheet 2

FIG.4.

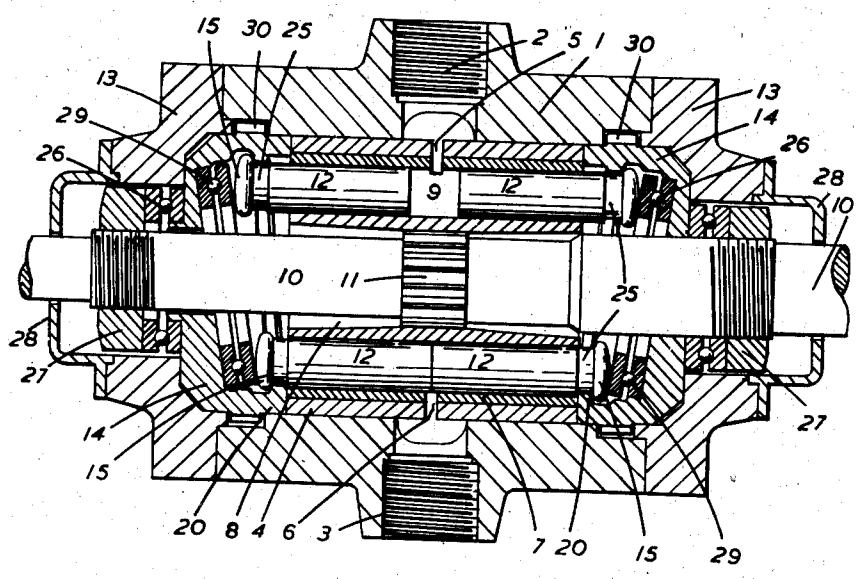
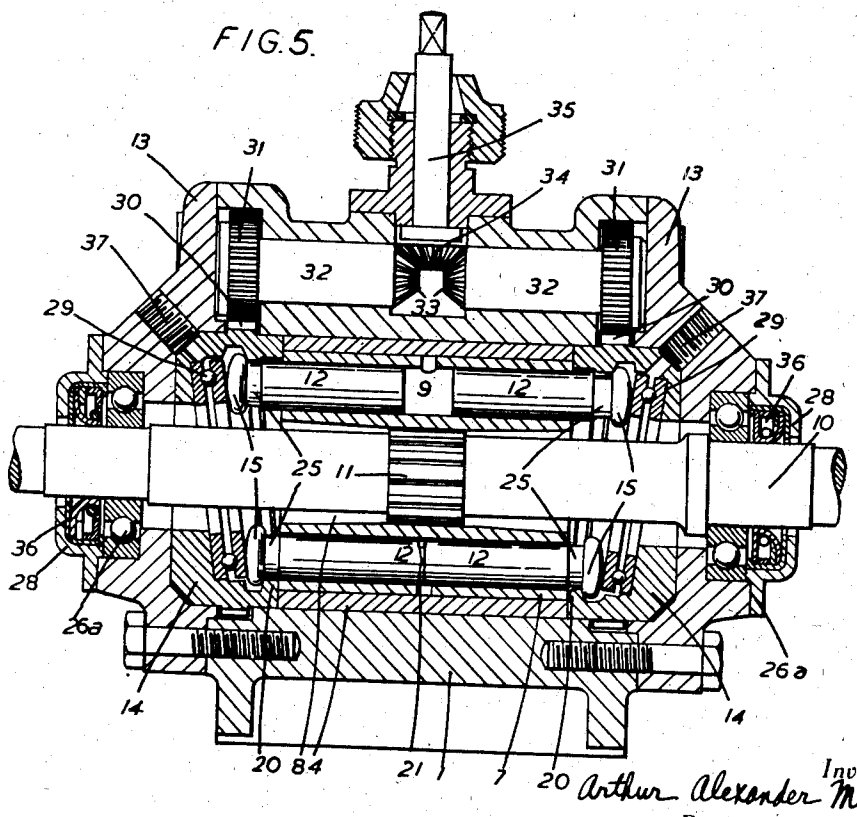



FIG.5.



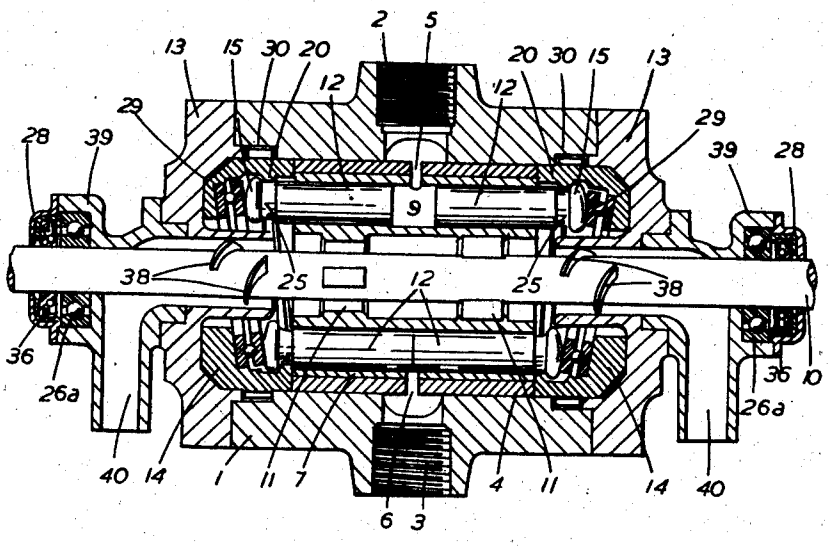

Inventor
Arthur Alexander Mercer
By
John B. Brady
Attorney

April 13, 1948. A. A. MERCER 2,439,668

PUMP OR COMPRESSOR

Filed April 3, 1944 3 Sheets-Sheet 3

FIG. 6.




Arthur Alexander Mercer Inventor

By John B. Brady

Attorney

Patented Apr. 13, 1948

2,439,668

# UNITED STATES PATENT OFFICE

2,439,668

## PUMP OR COMPRESSOR

Arthur Alexander Mercer, Colchester, England, assignor of ten per cent to Bernard Mason, Colchester, England

Application April 3, 1944, Serial No. 529,293
In Great Britain April 21, 1943

6 Claims. (Cl. 103—162)

1

This invention relates to pumps (or compressors) of the kind comprising a closed cylindrical casing having diametrically opposed inlet and delivery ports at its medial plane, a rotor in the casing having a plurality of cylinders extending through it parallel to its axis of rotation and a port extending radially outwards from each cylinder to register periodically with the said inlet and delivery ports, a shaft for driving the rotor, and a pair of opposed plungers reciprocable in each of said cylinders as the rotor rotates.

An object of the invention is to devise a pump of this kind, for fixed or variable delivery according to requirements, which is of improved and simplified construction not requiring complicated and costly machinery or assembling operations, and in which such wear as is reasonable is confined to easily replaceable parts.

To the attainment of this object the invention provides in a pump of the stated kind the combination of two normally stationary end rings each presenting a circular cam track, and portions at the outer ends of the opposed pairs of plungers shaped to embrace the said tracks, whereby the opposed plungers are positively and mechanically displaced on both their outward and inward strokes as the pump rotor rotates in a smooth manner without danger of impact shocks and resultant wear and noise. Preferably, the plungers are shaped, at their outer ends, to afford shoulders or necked portions that embrace the circular tracks presented by the said end rings.

The said circular tracks may be curved to bring about, during each complete rotation of the pump rotor, outward displacement of each pair of opposed plungers while they pass the inlet port in the casing, followed by a period of axial immobility, followed by inward displacement while they pass the delivery port in the casing, followed by a second period of axial immobility until the beginning of the next cycle. However, and especially for high speed pumps, the two end rings may present plane circular tracks disposed obliquely to the axis of the rotor and embraced by the shaped portions of the plungers as aforesaid.

Variable rate of delivery of the pump can be obtained by providing either for axial displacement of the rotor thereby at least partially to mask the rotor ports while they traverse the inlet and delivery zones of the stator, or for angular displacement of the end rings simultaneously in opposite directions to alter the timing of the fluid inlet and delivery at each cycle.

Simple manually controllable means for axially

2

displacing the rotor comprises a threaded shaft screwed into one of the end covers of the pump casing and having a head engaging a counter bore in the rotor in such manner that whilst the rotor is free to rotate relatively to the threaded shaft, any axial displacement of the latter (by screwing it in the aforesaid end cover) results in a corresponding axial displacement of the rotor.

On the other hand, simple manually controllable means for angularly displacing the end rings as and for the purpose stated comprises a pair of aligned pinion shafts mounted in the pump casing parallel to the rotor, bevel wheels connecting the inner ends of the pinion shafts to a manual control shaft projecting from the casing, and gear wheels at the outer ends of the pinion shafts engaging teeth formed externally on the end rings or on turnable carriers accommodating the same.

By way of non-limitative example some constructional forms of pumps embodying the recited features of the invention are illustrated by the accompanying drawings, whereon:

Figs. 1 and 2 show one form embodying profiled end cams, Fig. 1 representing a horizontal axial section, and Fig. 2 a medial cross section in the plane II—II of Fig. 1;

Fig. 3 is a similar view to Fig. 1 of another form embodying profiled end cams, the pump drive shaft being omitted;

Fig. 4 represents a horizontal axial section of a form embodying plane, obliquely disposed cams;

Fig. 5 represents a vertical axial section of another form embodying plane, obliquely disposed cams, and shows means for manually turning the cam carriers to alter the setting of the cams; and

Fig. 6 shows in horizontal axial section a form which embodies an internal circulatory system for a coolant and lubricant.

Referring first generally to the several figures of the drawings, whereon the same references are used throughout to denote the same or similar parts, 1 is an open-ended cylindrical casing or stator with diametrically opposite inlet and delivering branches 2 and 3, 4 a wear resisting stator lining with inlet and delivery ports 5 and 6, 7 a rotor having a central bore 8 and any desired number of open-ended cylinders 9 equally spaced apart near its periphery with their axes parallel to that of the rotor, 10 a rotor drive shaft, 12 plungers slidable in the cylinders, 13 end covers for the casing, and 14 end ring members presenting cams or wipers that co-act with the plungers. These plungers are grouped in opposed pairs and each pair is slidable in one of the cylinders 9, i. e.,

each cylinder in the single rotor 7 is common to two opposed plungers 12, 12.

Referring now particularly to Figs. 1 and 2, the rotor 7 is splined, at 11, to the co-axial drive shaft 10, which is journalled in one of the end covers 13 for the casing 1, so that it is compelled to rotate with the shaft but is free to slide axially thereon within the stator lining 4, bearing rollers 16 being provided between the rotor and the lining. The two end rings 14, 14 are fixedly clamped, one between each end of the stator and the pertaining end cover 13; they present cam tracks 17 embraced by U-shaped heads 18 formed integral with the outer ends of the opposed pairs of plungers 12, 12. The plunger heads 18 bear on hardened sleeves 19, 19 carried by the internal bosses of the end covers 13, 13 and they engage the cam tracks through the intermediary of anti-friction bearings 20, 20.

A fluid space is afforded in each cylinder 9 between the two oppositely movable plungers 12, 12 therein and from this space each cylinder has a radial port 21 (see Fig. 2) opening to the periphery of the rotor 7 and adapted to register with the stator inlet and delivery ports 5 and 6. As will be evident from the illustration, the arrangement is such that at any instant in the rotation of the rotor 7 a number of cylinders 9 will be open to suction with their opposed plungers at various stages of outward movement, a number will be open to delivery with their opposed plungers at various stages of inward movement, and the remaining cylinders will be masked or closed by the stator lining 4.

When the shaft 10 is rotated, the rotor 7 is also rotated together with the plungers 12. Then, owing to the operative connection between the opposed plunger heads 18, 18 and the cam tracks 17, 17 afforded by the fixed end cam rings 14, 14 the plungers are axially displaced in the rotor cylinders 9, and since they move in opposite directions in pairs the fluid space between them is repeatedly varied to a constant extent. Obviously, the cam tracks are so profiled and so related to the inlet and outlet ports aforesaid that the opposed plungers move apart while passing the inlet port 5 and towards one another while passing the delivery port 6. While passing over from inlet to delivery and from delivery to inlet, no axial movement of the plungers occurs, the cam tracks being profiled to bring about these dwells.

A threaded shaft 22 (Fig. 1) is screwed into a screw-threaded bore in one of the end covers 13; it carries a ball bearing 23 whose outer race fits a slight enlargement in one end of the central bore 8 in the rotor 7. Thus, the rotor is free to turn relative to the threaded shaft 22, but by turning the threaded shaft and thereby displacing it axially the rotor is also displaced axially, to shift the ports 21 of the rotor cylinders 9 partly or wholly from coincidence with the inlet and delivery ports 5 and 6 in the stator lining and so vary the pump delivery. If desired and to ensure a fine degree of adjustment of delivery, the ports 21 may be circumferentially staggered or offset.

Passing now to Fig. 3, the pump there shown is very similar to that of Figs. 1 and 2, the chief modifications being that the end rings 14, 14 each present a circular profiled cam track 20 and an associated undercut profiled recess while the opposed pairs of plungers 12, 12 have neck portions 25, 25 embracing the cam track, and spherical ends 15, 15 engaging the base wall of the recess.



This arrangement simplifies the machining of the plungers. The cam tracks and recess are profiled the same as the cam tracks 20, 20 of the pump according to Figs. 1 and 2, and the operation of both forms of pump is similar. That of Fig. 3 is, however, a fixed delivery pump, no provision being made for axially displacing the rotor.

In the constructional form of the pump shown by Fig. 4 the rotor drive shaft 10 extends right through the pump casing 1 and is journalled by means of thrust ball races 26, 26 retained by nuts 27, 27 screwed on the shaft. The casing end covers 13, 13 are equipped with sealing caps 28, 28. In this instance the ring members 14, 14 are turnably mounted, about the rotor axes, between the end covers and the ends of the stator lining 4; each of them presents a plane, inclined cam track 20 embraced by necked portions 25 at the outer ends of the plungers 12, and an undercut recess wherein is located an obliquely set ball bearing 29 whose inner race is engaged by the spherical outer ends 15 of the plungers. The reactionary forces from the plungers are transferred through the carrier rings and the ball bearings to the drive shaft, this arrangement being especially suitable for heavy duty pumps. During the operation of the pump the ring members 14, 14 do not rotate, but under the outward thrusts of the plungers the inner races of the ball bearings 29 may turn with the plungers, an arrangement which reduces wear. Since the tracks 20, 20 are plane oblique flanges there will be no period of axial immobility of the opposed pairs of plungers 12, 12 which at each rotation of the rotor will move without pause outwardly from one another and then inwardly towards one another.

Variable rate of delivery of the pump is obtained by turning the ring members 14, 14 simultaneously in opposite directions, thereby to vary the distances apart of the opposed plungers as they pass the pump inlet and outlet zones. To this end the ring members have external gear teeth 30, 30 and, as is shown in the embodiment illustrated by Fig. 5, two shafts 32, 32 journalled in the pump casing 1 have spur gears 31, 31 engaging these teeth; moreover the two shafts also have bevel gears 33, 33 which mesh with a bevel gear 34 on a manually turnable shaft 35 extending from the casing.

Substantially the only difference between the embodiment of the pump shown by Fig. 5 and that of Fig. 4 is in the manner of mounting the rotor drive shaft 10. In Fig. 5 journal ball races 26a, 26a are employed, and the shaft end caps contain known oil sealing means 36, 36. In Fig. 5 can also be seen ducts 37, 37 for connection to a supply of lubricant.

In the embodiment of the invention illustrated by Fig. 6, the cam or wiper mechanism for ensuring reciprocation of the opposed pairs of plungers 12, 12 when the rotor 7 is driven and the mechanism for manually varying the rate of delivery is identical with those of the forms of the pump already described with reference to Figs. 4 and 5. Here, however, provision is made for circulating a lubricating and cooling medium continuously through the interior of the pump. As shown the drive shaft 10 is connected to the rotor 7 by two sets of splines 11, 11, those of one set being displaced or offset 90° with respect to the other to afford a through passage for the medium. The drive shaft also has mounted thereon helical impeller vanes 38, 38. The ball races 26a, 26a in which the drive shaft is journalled are contained

in housings afforded by members 39, 39 to which are secured the shaft end caps 28, 28 containing the seals 36, 36. These members 39, 39 are formed with tubular branches 40, 40 adapted to be connected to an external closed circuit (not shown) for the lubricating and cooling medium. It will be evident that with this arrangement the impellers 33, 33 will cause a through flow of the medium which has free access to the working parts within the pump casing.

The entire pump in each of the forms described and illustrated is constituted by few working parts under elimination of valves, and the machining of the said parts consists almost entirely of straightforward turning operations. The end thrusts of the opposed plungers are balanced, so that neither the rotor nor the rotor drive shaft is subjected to end thrusts from which follows that wear of the pump parts is reduced to the minimum. In fact substantially the entire wear occurs on the plunger heads, and the plungers presenting these heads are easily renewable at small cost. There are no springs or equivalent members likely to cause trouble, the plungers being positively reciprocated, smoothly and without noise, by the cam or wiper tracks which their outer ends embrace.

It is to be observed that cam rings remain stationary during the operation of the pump and that the reciprocating plungers rotate with the rotor and its drive shaft but without these latter being subjected to end thrusts.

Pumps in accordance with the invention may be used for divers purposes. They are well adapted, for instance, for the fuel injection systems of internal combustion engines, and for hydraulically operated mechanisms on aircraft and machine tools.

I claim:

1. In a pump of the kind comprising a closed cylindrical casing having diametrically opposed inlet and delivery ports at its medial plane, a rotor in the casing having a plurality of cylinders extending therethrough parallel to its axis of rotation, and a port extending radially outwards from each cylinder to register periodically with the said inlet and delivery ports, a shaft for driving the rotor, and a pair of opposed plungers reciprocable in each of the said cylinders as the rotor rotates; the combination of means for positively and mechanically displacing the opposed plungers on both their outward and inward strokes, said means comprising two normally stationary end rings each presenting a circular cam track, and portions at the outer ends of the opposed plungers shaped to embrace the said tracks; and means for varying the delivery by partially masking the rotor ports comprising a shaft screw-threaded in the pump casing, and a head on the shaft engaging a counterbore in the rotor whereby the rotor is axially displaced by turning the said shaft.

2. In a pump of the kind comprising a closed cylindrical casing having diametrically opposed inlet and delivery ports at its medial plane, a rotor in the casing having a plurality of cylinders extending therethrough parallel to its axis of rotation, and a port extending radially outwards from each cylinder to register periodically with the said inlet and delivery ports, a shaft for driving the rotor, and a pair of opposed plungers reciprocable in each of the said cylinders as the rotor rotates; the combination of means for positively and mechanically displacing the opposed plungers on both their outward and inward strokes, said means comprising two normally stationary end rings each presenting an inclined thrust race and spaced therefrom a circular cam track, rounded heads at the outer ends of the opposed plungers to abut said thrust races and necked portions adjacent said heads to embrace the said tracks; and means for varying the delivery by partially masking the rotor ports comprising a shaft screw-threaded in the pump casing, and a head on the shaft engaging a counterbore in the rotor whereby the rotor is axially displaced by turning the said shaft.



3. In a pump of the kind comprising a closed cylindrical casing having diametrically opposed inlet and delivery ports at its medial plane, a rotor in the casing having a plurality of cylinders extending therethrough parallel to its axis of rotation, and a port extending radially outwards from each cylinder to register periodically with the said inlet and delivery ports, a shaft for driving the rotor, and pair of opposed plungers reciprocable in each of the said cylinders as the rotor rotates; the combination of means for positively and mechanically displacing the opposed plungers on both their outward and inward strokes, said means comprising two normally stationary end rings each presenting a circular cam track, and portions at the outer ends of the opposed plungers shaped to embrace the said tracks, the said tracks being profiled to bring about, during each complete rotation of the rotor, outward axial displacement of each pair of opposed plungers while they pass the inlet port in the casing, followed by a period of axial immobility, followed by inward displacement while they pass the delivery port in the casing, followed by a second period of axial immobility until the beginning of the next cycle; and means for varying the delivery by partially masking the rotor ports comprising a shaft screw-threaded in the pump casing, and a head on the shaft engaging a counterbore in the rotor whereby the rotor is axially displaced by turning the said shaft.

4. In a pump of the kind comprising a closed cylindrical casing having diametrically opposed inlet and delivery ports at its medial plane, a rotor in the casing having a plurality of cylinders extending therethrough parallel to its axis of rotation, and a port extending radially outwards from each cylinder to register periodically with the said inlet and delivery ports, a shaft for driving the rotor, and a pair of opposed plungers reciprocable in each of the said cylinders as the rotor rotates; the combination of means for positively and mechanically displacing the opposed plungers on both their outward and inward strokes, said means comprising two normally stationary end rings each presenting an inclined thrust race and spaced therefrom a circular cam track, rounded heads at the outer ends of the opposed plungers to abut said thrust races and necked portions adjacent said heads to embrace the said tracks, the said tracks being profiled to bring about, during each complete rotation of the rotor, outward axial displacement of each pair of opposed plungers while they pass the inlet port in the casing, followed by a period of axial immobility, followed by inward displacement while they pass the delivery port in the casing, followed by a second period of axial immobility until the beginning of the next cycle; and means for varying the delivery by partially masking the rotor ports comprising a shaft screw-threaded in the pump casing, and

a head on the shaft engaging a counterbore in the rotor whereby the rotor is axially displaced by turning the said shaft.

5. In a pump of the kind comprising a closed cylindrical casing having diametrically opposed inlet and delivery ports at its medial plane, a rotor in the casing having a plurality of cylinders extending therethrough parallel to its axis of rotation, and a port extending radially outwards from each cylinder to register periodically with the said inlet and delivery ports, a shaft for driving the rotor, and a pair of opposed plungers reciprocable in each of the said cylinders as the rotor rotates; the combination of means for positively and mechanically displacing the opposed plungers on both their outward and inward strokes, said means comprising two normally stationary end rings each presenting a circular cam track, and portions at the outer ends of the opposed plungers shaped to embrace the said tracks; and means for varying the delivery rate by angularly displacing the two end rings simultaneously in opposite directions, said means comprising a pair of aligned pinion shafts mounted in the pump casing parallel to the rotor, a manual control shaft projecting from the casing, bevel wheels connecting the inner ends of the pinion shafts with the control shaft, and gear wheels at the outer ends of the pinion shafts engaging teeth formed externally on the end rings.

6. In a pump of the kind comprising a closed cylindrical casing having diametrically exposed inlet and delivery ports at its medial plane, a rotor in the casing having a plurality of cylinders extending therethrough parallel to its axis of rotation, and a port extending radially outwards from each cylinder to register periodically with the said inlet and delivery ports, a shaft for driving the rotor, and a pair of opposed plungers reciprocable in each of the said cylinders as the rotor rotates; the combination of means for positively and mechanically displacing the opposed plungers on both their outward and inward strokes, said means comprising two normally stationary end rings each presenting an inclined thrust race and spaced therefrom a circular cam track, rounded heads at the outer ends of the opposed plungers to abut said thrust races and necked portions adjacent said heads to embrace the said tracks; and means for varying the delivery rate by angularly displacing the two end rings simultaneously in opposite directions, said means comprising a pair of aligned pinion shafts mounted in the pump casing parallel to the rotor, a manual control shaft projecting from the casing, bevel wheels connecting the inner ends of the pinion shafts with the control shaft, and gear wheels at the outer ends of the pinion shafts engaging teeth formed externally on the end rings.



ARTHUR ALEXANDER MERCER.


REFERENCES CITED

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

UNITED STATES PATENTS

| Number | Name | Date |
|---|---|---|
| 1,180,190 | Robertson | Apr. 18, 1916 |
| 1,287,026 | Janney | Dec. 10, 1918 |
| 1,669,976 | De Leeuw | May 15, 1928 |
| 2,095,255 | Holmes | Oct. 12, 1937 |
| 2,192,539 | Condon | Mar. 5, 1940 |

FOREIGN PATENTS

| Number | Country | Date |
|---|---|---|
| 40,221 | Denmark | 1929 |
| 293,801 | Great Britain | Mar. 28, 1929 |
| 851,663 | France | Oct. 9, 1939 |