March 14, 1944. J. A. BELLAZINI 2,343,948

ROTARY MOTOR

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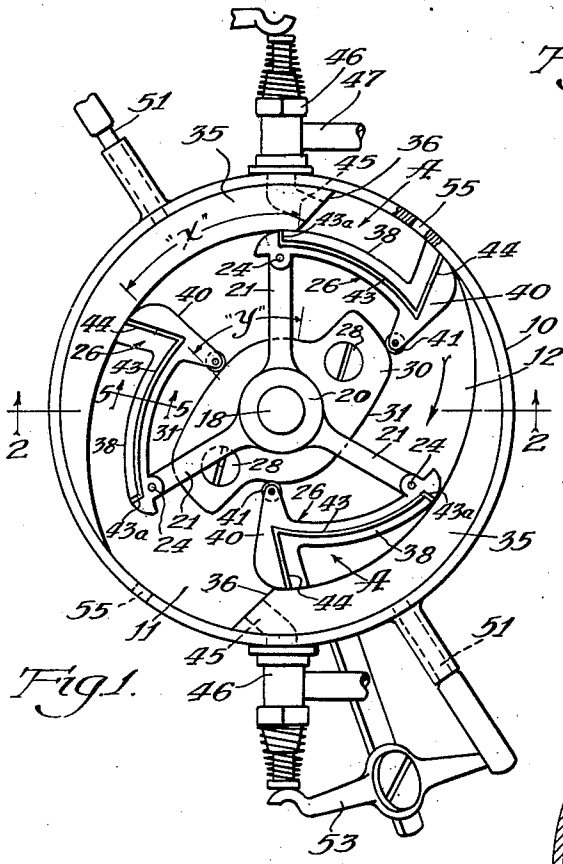


Fig. 1.

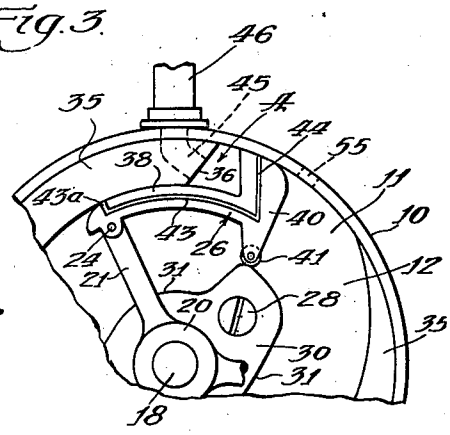


Fig. 3.

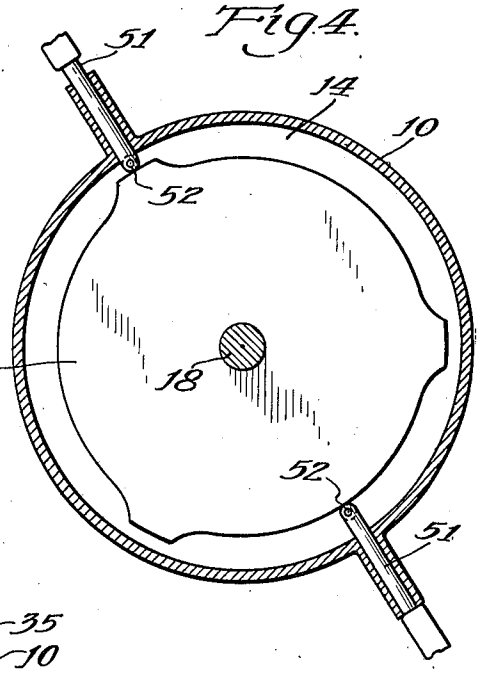


Fig. 4.

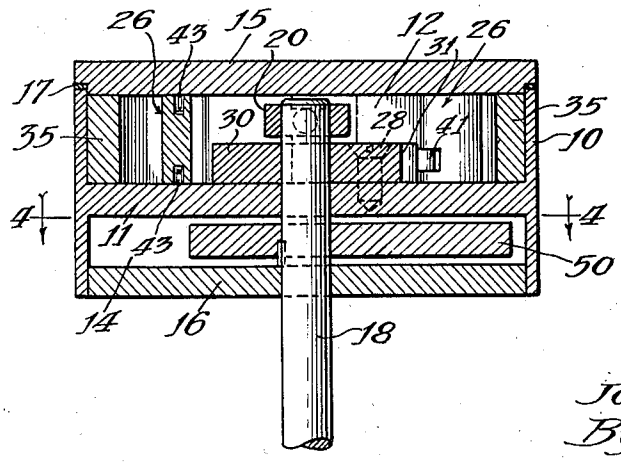


Fig. 2.

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Fig. 6.

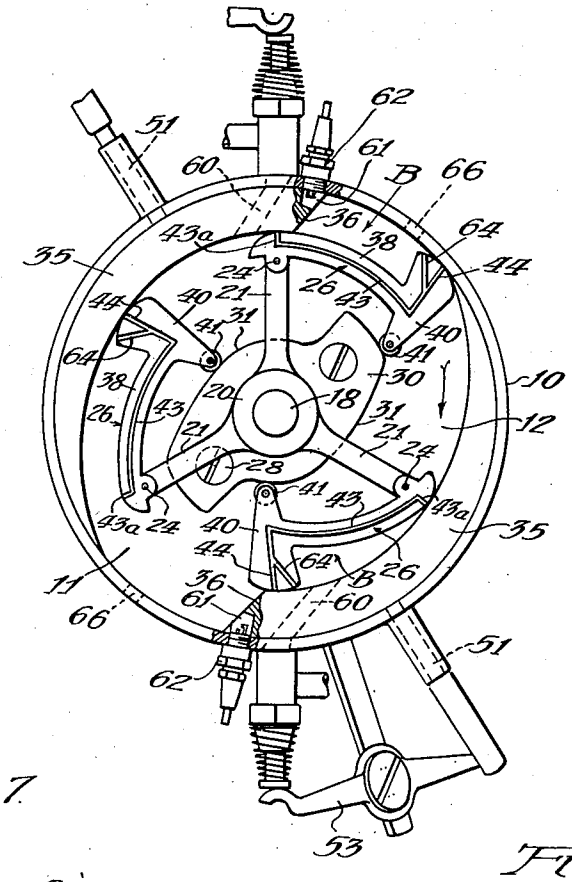


Fig. 7.

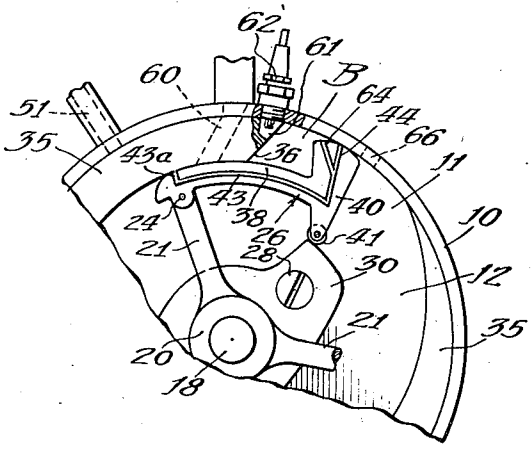
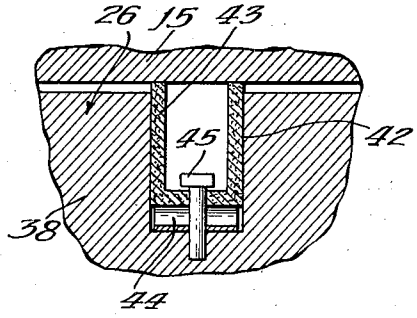


Fig. 5.



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UNITED STATES PATENT OFFICE

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ROTARY MOTOR

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7 Claims. (Cl. 123—17)

The present invention relates to rotary motors, and more particularly is directed to rotary motors of the type adapted to function as an engine, adapted to be operated either by steam, or as an internal combustion engine, or wherein the motor may function as a pump for the handling of liquids.

Motors of the general type to which the present invention pertains have heretofore been constructed so that the impeller elements or pistons each perform a single operating stroke during a complete revolution of the impeller. Such constructions are now considered inefficient because of a relatively limited amount of power capable of being produced thereby for a unit of given size, and because of the appreciable weight entailed in such design per unit of power produced or work capable of being done.

The present invention has for its primary object the provision of an improved motor of the character indicated, having a plurality of impellers or pistons each adapted during a single rotation to produce a plurality of operating or power strokes.

Another object is to provide an improved motor of the character indicated, characterized by the provision of a plurality of impellers pivotally mounted for rotary movement as a unit about the axis of the power shaft, and wherein a fixed cam together with the inner wall of the casing are cooperatively formed to control the path of movement of the impellers for causing the impellers to deliver a plurality of operating or power strokes during each single revolution of the power shaft.

A further object is to provide an improved motor of the character indicated which is relatively simple in construction, composed of a minimum number of parts, and which can be compactly arranged and which permit obtaining relatively high operating efficiency.

Still another object is to provide an improved motor of the character indicated, characterized by the provision of a plurality of impellers rotatable as a unit about the axis of a power shaft, between a pair of parallel top and bottom walls of a casing, together with fixed cam means arranged concentrically with respect to the axis of the power shaft, and cooperating inner walls of the casing by virtue of which the effective operating chamber of each impeller is gradually varied in cubical volume, incident to rotation about the axis of the shaft.

Other objects and advantages of this invention will be apparent from the following description, taken in connection with the accompanying drawings in which:

Fig. 1 is a top plan view of the motor embodying the present invention, shown as adapted for use as a steam engine, with the cover plate or head removed.

Fig. 2 is a transverse section through the motor, taken as indicated at line 2—2 in Fig. 1.

Fig. 3 is a fragmentary view similar to Fig. 1, showing one of the impeller elements in a different position of adjustment.

Fig. 4 is a transverse view through the motor, taken as indicated at line 4—4 in Fig. 2.

Fig. 5 is an enlarged, fragmentary sectional view, taken at line 5—5 on Fig. 1, showing the sealing arrangement of one of the impeller elements with respect to the walls of the casing.

Fig. 6 is a view similar to Fig. 1, showing a modified form of my motor, adapted for use as an internal combustion engine.

Fig. 7 is a fragmentary view similar to Fig. 6 of the modified form, showing one of the impeller elements in another position of adjustment.

In the construction represented in Figs. 1 to 5 of the drawings, the motor is shown as a steam engine and includes a cylindrical casing 10, provided with an intermediate partition wall 11 to form an upper closed main chamber 12, and a lower auxiliary chamber 14. The upper or main chamber 12 is adapted to be closed by a cover plate or head 15, and the bottom of the lower chamber 14 is closed by a plate 16. The upper cover plate or head 15 is adapted to be seated upon a sealing gasket 17 so as to completely seal the main chamber 12. Extending upwardly through the lower plate 16 and into both of the chambers 12 and 14, is a rotatable power shaft 18. It is to be understood that said shaft is provided with suitable bearings and seals (not shown) in the plate 16 and partition wall 11. The upper end of said shaft 18 terminates adjacent the under side of the cover plate or head 15.

Keyed to the upper end of the shaft 18, in the main chamber 12, is a carrier including a collar 20 provided with three circumferentially spaced apart radially extending arms 21, the arms being spaced apart equal angular distances. Pivotally connected at 24 to the outer end of each of the arms of the carrier is an impeller member 26, said impellers being rotatable with the carrier as a unit.

Mounted below the collar 20, and rigidly secured to the upper surface of the partition 11, by means of screws 28, is a fixed cam 30, disposed centrally relatively to the shaft 18. As may

be seen in Fig. 1 of the drawings, the peripheral or operating surface of the cam is composed of two identical, connected cam surfaces 31, for purposes hereinafter to be described.

Mounted adjacent the outer wall of the main chamber 12 are two identically and circumferentially spaced apart curved wall portions 35, having the curved surfaces thereof disposed inwardly of the wall of the casing, and merging at one end into the inner wall of the casing, and the other end terminating in an inclined surface as indicated at 36. The two curved wall portions 35 are disposed in diametrically opposite relation to each other and are so co-related with respect to the respective cam surfaces 31 of the cam 30 as to effect complete control of the position of impeller elements 26 in their movement about the axis of the power shaft 18. The center of curvature of the innermost portions of each of the curved wall portions 35, as indicated by the space marked X, on one of the portions 35, is at the axis of the shaft 18, and the center of curvature of the portions of the cam 30 as indicated on one of the cams 31 and, marked Y, is also located at the axis of the shaft 18. The entire inner curved surfaces of the curved wall portions 35, including the inclined portions 36, together with the remaining exposed portion of the inner wall of the casing 10, constitute a continuous sealing wall engageable by the impeller elements 26.

Each of the impeller elements 26 include a curved arm 38, the center of curvature thereof being also at the axis of the shaft 18, and the radius of curvature of the outer surface of the arms 38 being equal to the radius of curvature of the inner surfaces of wall portions 35 for the distance indicated at X. Consequently, when the shaft 18 is rotated, the outer surface of the arms 38 of the impellers adjacent the pivots 24, will move in close contact with the surfaces X and thus effect a seal therewith.

The ends of the impeller elements opposite the pivot 24 are formed with cross members 40. The outer end of each cross member is adapted to ride upon the inner surface of the curved wall portions 35 and also the remaining inner surface of the wall of the casing 10. The opposite or inner ends of the cross members are provided wtih rollers 41 which are adapted to ride upon the cam surfaces 31.

The top and bottom surfaces of the impeller elements 26 are formed with grooves 42 in which are seated seal element 43 of U-shaped cross section which are urged outwardly with respect to the surface of the impeller elements by means of sinuous form of leaf springs 44, the spring and the seal elements being loosely secured in position in the grooves 42 by rivets 45, which have their heads spaced from the bottom of the seals, as seen in Fig. 5, as to allow adequate range of flexibility for permitting the springs to urge the seals outwardly into sealing engagement with the adjacent surface of the partition 11 and the under side of the cover plate 15. As may be seen in Fig. 1 of the drawings, the seal 43 extends lengthwise of the arm 38 of the impeller, terminating adjacent the pivot 24, in an outwardly extending portion, 43*a*, at the outer periphery of the curved surface of the arm 38. At the opposite end of the impeller element, a seal 44, is disposed at an obtuse angle to the main seal 43, and the outer end of said seal 44 terminates in sealing engagement with the inner sealing wall of the chamber. It is by virtue of the sealing arrangement described that the impellers each form gradually varying size sealed chambers, A, at certain rotative positions of adjustment, as may be seen by the position of the impellers in the upper and lower portions of Fig. 1 of the drawings.

Opening into the interior of the main chamber 12, at each of the inclined surfaces 36 of the curved wall portions 35, is a steam inlet port 45, each of said ports being separately controlled by valves 46, which communicate with a separate steam supply conduit 47.

In operation, steam is introduced into the inlet ports 45, under control of the valve 46, behind the cross members 40 of the impeller elements. Introduction of the steam, however, desirably must be controlled in timed relationship to the impellers 26, and for this purpose a cam 50 is keyed to the shaft 18 in the lower compartment or chamber 14. A pair of oppositely disposed push rods 51, carrying rollers 52 at their inner ends, are adapted to ride upon the lobes of the cam 50, and each of said push rods being connected to a lever 53 which functions to control the adjacent valve 46. When the shaft 18 is in the position substantially as indicated in Fig. 3 of the drawings, one of the lobes of the cam 50 has engaged the corresponding push rod 51, operating the lever 53, for causing an opening of the adjacent valve 46, admitting steam through the inlet port 45. It will be apparent that the steam, as may be clearly understood from Fig. 3 of the drawings, will be introduced in the chamber A, behind the cross member 40 of the impeller, after the member 40 passes beyond the inlet port 45, and as the steam expands, it will cause clockwise rotation of the impeller, thereby imparting rotary motion to the shaft 18 in a clockwise direction. During this movement the arm 38 of the impeller, adjacent the pivot end 24, rides in sealing contact upon the surface X of the adjacent curved wall portion 35 and effects a seal therewith and the outer portion of the cross head 40 is maintained in sealing engagement with the inner surface of the casing by the cam 30 acting through the roller 41 of the cross head.

The number of lobes of the cam 50 corresponds to the number of impellers, herein shown as three, and it will be appreciated that steam is caused to be introduced behind the cross head of each impeller as it passes each of the inlet ports 45. After the impellers have moved a substantial distance by the action of the steam, the cam 50 arrives at a position to disengage the push rod 51, and the supply of steam to the inlet ports 45 is cut off. Slight further rotary movement of the impeller then causes the variable chamber, formed by the sealing engagement of the impeller with the sealing wall of the chamber, to come into registry with an exhaust port 55, as seen in Fig. 1, formed in the wall of the casing, and which permits the steam behind the cross head to be exhausted, there being an exhaust port, adjacent each inlet port. Thus, by virtue of the construction described, each impeller during a single revolution about the axis of the shaft 18 performs two separate power strokes. It is by virtue of this construction that it is possible to obtain a relatively high speed motor which is efficient and compact and of minimum weight for the amount of power produced thereby.

In Figs. 6 and 7 of the drawings I have shown shown a modified form of my improved motor, which is constructed to function as an internal

combustion engine. The construction shown in Figs. 6 and 7 is identical with that represented in Figs. 1 and 3 of the drawings with the exception that the fuel inlet ports indicated at **60** open to the interior of the chamber through the curved wall portions **35**, adjacent the inclined surfaces **36**, and seated in openings **61** formed in the inclined portions **36** of said curved wall portions are spark plugs **62**. For such use the cross head of the impeller is of slightly modified contour and includes an auxiliary sealing gasket **64** at the upper end of the cross head **40**, to insure maintenance of sealing engagement with the inclined surfaces **36**, as well as the other portions of the continuous sealing wall, as the impeller rotates within the casing.

It will be understood, of course, that the lobes of the cam **50** which control the fuel inlet will be of slightly modified shape so as to afford a shorter interval of time for the introduction of the combustible mixture. Said mixture is forcibly injected by suitable power driven means not shown. It will now be seen that when the impeller is in the position shown at the lower portion of Fig. 6 of the drawings, the terminal portion **43***a* of the sealing gasket, and the end of the auxiliary sealing gasket **64** are in such a position as to form a completely enclosed chamber B. As the impeller **26** moves clockwise, the outer end of the cross head rides down the inclined surface **36**, with the sealing gasket **64** in contact with said inclined surface for maintaining sealing of the combustible mixture in the chamber B. During this period the effective cubical volume of the chamber B is gradually reduced, thus compressing the combustible fuel in said chamber B.

At the end of the compression stroke, which will correspond to the position of the impeller at which the chamber B is of minimum volumetric contents, it may be understood that the spark plug **62** is caused to ignite the compressed combustible mixture, thus imparting a power stroke to the back of the cross head of the impeller, driving it forwardly in clockwise direction. Such forward movement causes the volumetric size of the chamber B to increase until the chamber B comes into registration with an exhaust port **66**, for permitting the gases caused by explosion of the combustible mixture to be exhausted. While I have not shown or described any operating connections for timing of the spark plugs, it is to be understood that any suitable conventional arrangement may be employed, and if desired may be connected for timed operation by the operating shaft **18**. When the motor is utilized as an internal combustion engine the advantages of its construction will be attained in the same manner as when used as a steam engine, namely, in that each impeller during a single revolution will have imparted thereto two separate applications of power for effecting rotation of the shaft **18**.

Furthermore, it will be noted that my improved motor, both in the form of a steam engine and an internal combustion engine, is so designed that as to obtain an improved mechanical advantage not heretofore attained by reason of the lever arm of each impeller being considerably greater in length than the power stroke of the impeller. It will be apparent, however, that if desired, my engine may be so designed that the lever arm of the impeller and the power stroke are of equal lengths.

The novel construction of motor herein disclosed also lends itself for satisfactory and efficient embodiment as a pump. When the motor is to be used as a pump obviously the connections for steam and/or combustible fuel may be dispensed with and the shaft **18** will then be power driven for rotating the impellers in a counterclockwise direction or in other words, reverse from the direction when it is used as an engine.

Although I have herein shown and described certain preferred embodiments of my invention, manifestly it is capable of further modification and rearrangement of parts without departing from the spirit and scope thereof I do not, therefore, wish to be understood as limiting this invention to the precise forms herein disclosed, except as I may be so limited by the appended claims.

I claim as my invention:

1. In a device of the character described, the combination of a casing including a closed main chamber, a plurality of curved circumferentially spaced apart wall portions spaced inwardly from the inner wall of the casing, each of said wall portions merging at one end into the inner wall of the casing and the other end terminating in an inclined surface extending to said inner wall of the casing, said curved wall portions together with portions of the inner wall of the casing constituting a continuous sealing wall, a centrally disposed rotatable shaft extending into the chamber of the casing, a cam fixedly secured in position in the chamber in central relationship to the axis of the shaft, said cam having a plurality of similar connected cam surfaces, a carrier fixedly secured on the shaft within said main chamber, and a plurality of circumferentially spaced apart impellers pivotally connected to said carrier, the portion of each impeller, opposite the pivot, having an inner end positioned in engagement with the periphery of the cam, and an outer end engaging said sealing wall, said curved wall portions and cam surfaces being of corresponding number and disposed in such correlation as to cause said outer ends of the impellers to maintain sealing engagement with said sealing wall, said impellers each being of elongated formation engaging top and bottom walls of the main chamber and having a portion adjacent its pivot formed to engage said sealing wall at certain angular positions of adjustment in the main chamber which together with the engagement of the opposite end of the impeller with the sealing wall forms a closed variable chamber.

2. In a device of the character described, the combination of a casing including a closed main chamber, a plurality of curved circumferentially spaced apart wall portions spaced inwardly from the inner wall of the casing, each of said wall portions merging at one end into the inner wall of the casing and the other end terminating in an inclined surface extending to said inner wall of the casing, said curved wall portions together with portions of the inner wall of the casing constituting a continuous sealing wall, a centrally disposed rotatable shaft extending into the chamber of the casing, a cam fixedly secured in position in the chamber in central relationship to the axis of the shaft, said cam having a plurality of similar connected cam surfaces, a carrier fixedly secured on the shaft within said main chamber, and a plurality of circumferentially spaced apart impellers pivotally connected to said carrier, the portion of each impeller, opposite the pivot, having an inner end positioned in engagement with the

periphery of the cam, and an outer end engaging said sealing wall, said curved wall portions and cam surfaces being of corresponding number and disposed in such correlation as to cause said outer ends of the impellers to maintain sealing engagement with said sealing wall, said impellers each being of elongated formation and having a portion adjacent its pivot formed to engage said sealing wall at certain angular positions of adjustment in the main chamber which together with the engagement of the opposite end of the impeller with the sealing wall forms a closed variable chamber, said main chamber being provided with a plurality of pairs of inlet and outlet ports corresponding in number to said cam surfaces said inlet and outlet ports being positioned to have the closed variable chambers formed by the impellers sequentially registered therewith and said variable chambers gradually increasing in cubical dimensions from the time of registry with an inlet port until the time of registry with an exhaust port, whereby each impeller is adapted to deliver a plurality of operating strokes during each complete revolution.

3. In a device of the character described, the combination of a casing including a closed main chamber, a plurality of curved circumferentially spaced apart wall portions spaced inwardly from the inner wall of the casing, each of said wall portions merging at one end into the inner wall of the casing and the other end terminating in an inclined surface extending to said inner wall of the casing, said curved wall portions together with portions of the inner wall of the casing constituting a continuous sealing wall, a centrally disposed rotatable shaft extending into the chamber of the casing, a cam fixedly secured in position in the chamber in central relationship to the axis of the shaft, said cam having a plurality of similar connected cam surfaces, a carrier fixedly secured on the shaft within said main chamber, and a plurality of circumferentially spaced apart impellers pivotally connected to said carrier, the portion of each impeller, opposite the pivot, having an inner end positioned in engagement with the periphery of the cam, and an outer end engaging said sealing wall, said curved wall portions and cam surfaces being of corresponding number and disposed in such correlation as to cause said outer ends of the impellers to maintain sealing engagement with said sealing wall, said impellers each being of elongated formation engaging top and bottom walls of the main chamber and having a portion adjacent its pivot formed to engage said sealing wall at certain angular positions of adjustment in the main chamber to form a variable chamber, said main chamber being provided with steam inlet ports in each of said inclined surfaces of said curved wall portions, and outlet ports spaced circumferentially relatively to the inlet ports, whereby said variable chambers formed by said impellers are caused to sequentially register respectively with said inlet and outlet ports.

4. In a device of the character described, the combination of a casing including a closed main chamber, a plurality of curved circumferentially spaced apart wall portions spaced inwardly from the inner wall of the casing, each of said wall portions merging at one end into the inner wall of the casing and the other end terminating in an inclined surface extending to said inner wall of the casing, said curved wall portions together with portions of the inner wall of the casing constituting a continuous sealing wall, a centrally disposed rotatable shaft extending into the chamber of the casing, a cam fixedly secured in position in the chamber in central relationship to the axis of the shaft, said cam having a plurality of similar connected cam surfaces, a carrier fixedly secured on the shaft within said main chamber, a plurality of circumferentially spaced apart impellers pivotally connected to said carrier, the portion of each impeller, opposite the pivot, having an inner end positioned in engagement with the periphery of the cam, and an outer end engaging said sealing wall, said curved wall portions and cam surfaces being of corresponding number and disposed in such correlation as to cause said outer ends of the impellers to maintain sealing engagement with said sealing wall, said impellers each being of elongated formation engaging top and bottom walls of the main chamber and having a portion adjacent its pivot formed to engage said sealing wall at certain angular positions of adjustment in the main chamber to form a variable chamber, said main chamber being provided with steam inlet ports in each of said inclined surfaces of said curved wall portions, and outlet ports spaced circumferentially relatively to the inlet ports, whereby said variable chambers formed by said impellers are caused to sequentially register respectively with said inlet and outlet ports, and timing means for supplying steam through the inlet ports when the variable chambers of the impellers are in registration therewith.

5. In a device of the character described, the combination of a casing including a closed main chamber, a plurality of curved circumferentially spaced apart wall portions spaced inwardly from the inner wall of the casing, each of said wall portions merging at one end into the inner wall of the casing and the other end terminating in an inclined surface extending to said inner wall of the casing, said curved wall portions together with portions of the inner wall of the casing constituting a continuous sealing wall, a centrally disposed rotatable shaft extending into the chamber of the casing, a cam fixedly secured in position in the chamber in central relationship to the axis of the shaft, said cam having a plurality of similar connected cam surfaces, a carrier fixedly secured on the shaft within said main chamber, a plurality of circumferentially spaced apart impellers pivotally connected to said carrier, the portion of each impeller, opposite the pivot, having an inner end positioned in engagement with the periphery of the cam, and an outer end engaging said sealing wall, said curved wall portions and cam surfaces being of corresponding number and disposed in such correlation as to cause said outer ends of the impellers to maintain sealing engagement with said sealing wall, said impellers each being of elongated formation engaging top and bottom walls of the main chamber and having a portion adjacent its pivot formed to engage said sealing wall at certain angular positions of adjustment in the main chamber to form a variable chamber, said main chamber being provided with steam inlet ports in each of said inclined surfaces of said curved wall portions, and outlet ports spaced circumferentially relatively to the inlet ports, whereby said variable chambers formed by said impellers are caused to sequentially register respectively with said inlet and outlet ports, and timing means for supplying steam through the inlet ports when the variable chambers of the impellers are in registration therewith, said timing

means including a cam fixedly secured on said shaft outside of the main chamber, together with operating followers cooperating with said cam for controlling the inlet ports.

6. In a device of the character described, the combination of a casing including a closed main chamber, a plurality of curved circumferentially spaced apart wall portions spaced inwardly from the inner wall of the casing, each of said wall portions merging at one end into the inner wall of the casing and the other end terminating in an inclined surface extending to said inner wall of the casing, said curved wall portions together with portions of the inner wall of the casing constituting a continuous sealing wall, a centrally disposed rotatable shaft extending into the chamber of the casing, a cam fixedly secured in position in the chamber in central relationship to the axis of the shaft, said cam having a plurality of similar connected cam surfaces, a carrier fixedly secured on the shaft within said main chamber, a plurality of circumferentially spaced apart impellers pivotally connected to said carrier, the portion of each impeller, opposite the pivot, having an inner end positioned in engagement with the periphery of the cam, and an outer end engaging said sealing wall, said curved wall portions and cam surfaces being of corresponding number and disposed in such correlation as to cause said outer ends of the impellers to maintain sealing engagement with said sealing wall, said impellers each being of elongated formation engaging top and bottom walls of the main chamber and having a portion adjacent its pivot formed to engage said sealing wall at certain angular positions of adjustment in the main chamber to form a variable chamber, said main chamber being provided with fluid fuel inlet ports opening through each of said curved wall portions, adjacent said inclined portions thereof, and exhaust ports spaced circumferentially relatively to said inlet ports, spark plugs seated in openings communicating with the interior of the chamber and located between each pair of inlet and outlet ports, and timing means operated from said shaft for controlling the supply of fuel to said inlet ports.

7. In a device of the character described, the combination of a casing including a closed main chamber, a plurality of curved circumferentially spaced apart wall portions spaced inwardly from the inner wall of the casing, each of said wall portions merging at one end into the inner wall of the casing and the other end terminating in an inclined surface extending to said inner wall of the casing, said curved wall portions together with portions of the inner wall of the casing constituting a continuous sealing wall, a centrally disposed rotatable shaft extending into the chamber of the casing, a cam fixedly secured in position in the chamber in central relationship to the axis of the shaft, said cam having a plurality of similar connected cam surfaces, a carrier fixedly secured on the shaft within said main chamber, a plurality of circumferentially spaced apart impellers pivotally connected to said carrier, the portion of each impeller, opposite the pivot, having an inner end positioned in engagement with the periphery of the cam, and an outer end engaging said sealing wall, said curved wall portions and cam surfaces being of corresponding number and disposed in such correlation as to cause said outer ends of the impellers to maintain sealing engagement with said sealing wall, said impellers each being of elongated formation engaging top and bottom walls of the main chamber and having a portion adjacent its pivot formed to engage said sealing wall at certain angular positions of adjustment in the main chamber to form a variable chamber, said main chamber being provided with fluid fuel inlet ports opening through each of said curved wall portions, adjacent said inclined portions thereof, and exhaust ports spaced circumferentially relatively to said inlet ports, spark plugs seated in openings formed in each of said inclined portions of said curved wall portions and communicating with the interior of the chamber and located between each pair of inlet and outlet ports, and timing means operated from said shaft for controlling the supply of fuel to said inlet ports.

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