PATENT SPECIFICATION

Application Date: July 5, 1922. No. 18,452/22. **206,196**

Complete Left: Feb. 17, 1923.

Complete Accepted: Nov. 5, 1923.

PROVISIONAL SPECIFICATION.

Improvements in connection with Valvular Arrangements of Internal Combustion Engines.

We, DOUGLAS GEORGE FISHER WHITE, of 6, Courtenay Street, Newton Abbot, in the County of Devon, Engineer, and LYON WILSON NEILSON, of 76, Netherlee Road, Cathcart, Glasgow, in the County of Renfrew, Engineer, both British subjects, do hereby declare the nature of this invention to be as follows:—

This invention relates to internal combustion engines working on the four stroke principle, and of the kind wherein the valvular arrangements comprise a vertical poppet valve that is a valve whose axis is parallel with the vertical axis of the cylinder which is opened at the proper times for induction and exhaust periods, and closed during the proper times for the compression and firing periods, and controls a port to and from the cylinder, which port is put into communication at the proper times with induction and exhaust passages, the ports for which are controlled by means of two rotary valves, one of which is for exhaust and the other for induction, these said rotary valves together with their ports being suitably arranged as close as is practicable to the said vertical poppet valve stem and head in such a way that the inert gases left in the pocket formed for the aforementioned poppet valve head shall have the minimum possible volume, and these said rotary valves are so operated and arranged that, when the said poppet valve is opened for the exhaust period the aforesaid rotary valve which controls the port to the exhaust passage is open, and the other said rotary valve, which controls the port to the inlet passage is closed, and the said vertical poppet valve, remaining open for the induction stroke, the rotary valve controlling the port to the inlet passage is open, while the other aforesaid rotary valve controlling the port to the exhaust passage is closed. These said rotary valves are arranged one on either side of the said vertical poppet valve and as close as is practicable to its stem and head, their axes being parallel to one another and diametrically opposite through a diametric line through the stem of the said vertical poppet valve. Further these said rotary valves or a rotary distributing valve are so arranged in their positions and directions of rotation that (1) any passage or passages between the port to and from the cylinder controlled by the vertical poppet valve, and the ports to the inlet and exhaust passages controlled by the said rotary valves are entirely eliminated, and the only means of communication between these said ports is through the actual and minimum pocket formed for the accommodation of the head of the said vertical poppet valve (2) the flat sides of these said rotary valves do not increase the volume of the pocket formed for the aforementioned vertical poppet valve head, between the exhaust and induction strokes, (3) that these said rotary valves are balanced, and (4) that the incoming charge is given direction by the cool flat of the aforesaid inlet rotary valve before it impinges on any hot spot other than where it is required to impinge for the most efficient running of the engine, *i.e.* on the head and stem of the said vertical poppet valve.

The foregoing description applies to a single cylinder engine cooled by air, water, oil or other means or to an engine cooled by air, water, oil or other

means having two or more cylinders cast separately. In the case of an engine cooled by air, water, oil, or other means having two or more cylinders cast *en bloc*, one rotary valve controlling the port to the exhaust passage may be used for two cylinders, together with two inlet rotary valves controlling the ports to the inlet passages, or one rotary valve controlling the port to the inlet passage may be used for two cylinders together with two exhaust rotary valves controlling the ports to the exhaust passages, or one inlet rotary valve controlling the ports to the inlet passages may be used for two cylinders, together with one exhaust rotary valve controlling the ports to the exhaust passages for two cylinders, or any such combination of rotary valves may be used for each cylinder or cylinders working together in each instance with a vertical poppet valve controlling the port to and from each cylinder, and further in each instance these rotary valves in each instance are so arranged that the volume of the pocket formed for the head of the vertical poppet valve for controlling the gases to and from each cylinder is cut down to its minimum, and the whole being suitably arranged and operated, and conforming with these several arrangements the axes of these said rotary valves may preferably be in a plane which is either parallel to or at right angles to the engine shaft and if parallel these said rotary valves may be constructed singly and suitably connected the one with the other, or two or more may be integrally constructed with a common axial centre line, and a series of these integral constructions of rotary valves may be suitably connected with others series of the same, while if the centre lines of the said rotary valves are at right angles to the engine shaft then these said rotary valves will preferably be constructed singly.

The object of our invention is to provide an improved construction of such valvular arrangements which while being as simple and efficient in action as possible ensures the maximum efficiency of the engine, volumetrically and otherwise as a direct result of the entire elimination of the aforesaid passages, and the using of a high compression ratio is also permitted, while the longevity of the engine is assured there being no high inertia stresses set up in or by the valve gear.

In the construction in accordance with our invention, in direct communication with the cylinder at the end where induction and exhaust take place is a valve casing, consisting of a casting, adapted to be secured by bolts, studs or other suitable means to the end of the cylinder, and comprising the port to and from the cylinder, a pocket formed for the head of the said poppet valve, directly in which pocket are situated the exhaust port and the induction port which give access to two housings or two circular seatings for the accommodation of the said rotary valves whose axes are preferably parallel with the engine shaft, and a seating for the vertical poppet valve and also a guide for the said vertical poppet valve. The said vertical poppet valve seating and the guide for the stem of the said valve are parallel with vertical axial centre line of the cylinder. The said poppet valve is suitably operated at the proper times by a rocking lever acted upon by a cam, this said cam being of the surface type, that is one on which the operating contour acts on the rocking lever in a line parallel with the axial centre line of the inlet rotary valve, on one end of which the said cam is suitably secured, the whole together with the exhaust rotary valve is conveniently driven by any suitable gear or gearing from the driving shaft of the engine. The said rotary valves have their axes preferably parallel with the engine shaft, and mounted on extended spindles, one on each end of the said rotary valves are separate circular collars of the same diameter as the rotary valves and being in close contact abutment with the ends of the said rotary valves, the peripheries of these said collars being recessed to accommodate one or more split spring packing rings, which said rings are allowed to float in their respective recesses. The said rotary valves are of hollow D-section partially open ended in which hollow D-section, a suitable vane or vanes may or may not be incorporated for the inducement of air for cooling purposes in a longitudinal direction through the D-section of the said rotary valves. Further in those portions of the aforesaid collars which coincide with the respective open ends of the said rotary valves, vanes of suitable constructions are incorporated to further induce or extract air through the said hollow rotary valves because of their rotary motion.

Between the said collars and the housings carrying the bearings for the extended spindles of the said rotary valves is left an annular air space, air being induced into or expelled from the said space by means of suitable gaps in the housings for the said bearings, and in addition to the above described longitudinal vaning in the D-section of the

said rotary valves and said vaned collars suitable cowling may or may not be arranged to guide a flow of air through the said gaps in bearing housings, the annular space aforementioned, the said vane collars, and the said hollow rotary valves.

The invention can be used for engines having one or more than one cylinder.

Dated this 4th day of July, 1922.

JOHN LIDDLE,
154, St. Vincent Street, Glasgow,
Chartered Patent Agent.

COMPLETE SPECIFICATION.

Improvements in connection with Valvular Arrangements of Internal Combustion Engines.

We, DOUGLAS GEORGE FISHER WHITE, of 6, Courtenay Street, Newton Abbot, in the County of Devon, Engineer, and LYON WILSON NEILSON, of 76, Netherlee Road, Cathcart, Glasgow, in the County of Renfrew, Engineer, both British subjects, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

Our invention relates to improvements in connection with valvular arrangements of internal combustion engines, working on the four stroke principle, and of the kind wherein the valvular arrangements comprise a poppet valve or valves each of which controls both induction and exhaust, being opened at the proper times for the induction and exhaust periods, and closed during the proper times for compression and firing periods, and this or these said poppet valve or valves operates in a pocket formed for its or their accommodation, and controls a port or ports to and from the cylinder, which port or ports, is or are put into communication at the proper times with induction and exhaust passages, the ports of which are controlled by two or other number rotary or other valves, one of which is for exhaust and the other for induction, and has for its object, the provision of an improved construction of such valvular arrangements which shall combine simplicity and accessibility and ensure the maximum efficiency of the engine as a direct result of cutting down to the minimum the volume of the previously mentioned pocket, and of entirely eliminating all passages or ducts common to both inlet and exhaust ports in which residual gases could lodge. The durability and longevity of the valves are assured, there being no high temperature or inertia stresses set up in or by the valve gear. According to our invention, the said rotary or other valves, together with their ports are suitably arranged as close as is practicable to the said poppet valve or valves stem and head, in such a way, and in order that the inert and residual gases left in the aforesaid pocket formed for the aforementioned poppet valve or valves head shall be of the minimum possible volume, and further this pocket volume is not increased owing to the entire elimination of any ducts or passages for induction and exhaust between the port to and from the cylinder and the ports to the induction and exhaust passages wherein residual gases could lodge, communication for induction and exhaust being effected by means of the ports which give access to the aforementioned pocket, these ports being directly incorporated in the wall of the said pocket formed for the accommodation of the said poppet valve or valves head. The said rotary or other valves are so operated and arranged that when the said poppet valve or valves is or are opened for the exhaust period, the aforesaid rotary or other valve which controls the port to the exhaust passage is open, and the other said rotary or other valve which controls the port to the inlet passage is closed, and the said poppet valve or valves, remaining open for the induction stroke, the rotary or other valve controlling the port to the inlet passage is open, while the aforesaid rotary or other valve controlling the port to the exhaust passage is closed. These said rotary or other valves are arranged one on either side of the said poppet valve or valves, and as close as is practicable to its or their stem or stems and head, and in the case of rotary valves their axes being preferably parallel to one another. Further such rotary valves are so arranged in their positions and directions of rotation that, (1) any passage or passages between the port to and from the cylinder controlled by the poppet valve or valves, and the ports to the inlet and exhaust passages controlled by the said rotary valves are absolutely eliminated. The only means of communication between the port to the inlet passage and the port or ports to and from the cylin-

der; and the port to the exhaust passage and the port or ports to and from the cylinder is through the actual and minimum pocket formed for the accommodation of the head of the said poppet valve, or valves, the ports to the inlet and exhaust passages being incorporated in the actual walls of the aforesaid pocket, and that (2) between the exhaust and induction strokes of the cycle the gaps or recesses in these said rotary valves, which are D-shaped in section, do not increase the volume of residual gases left above the port or ports to and from the cylinder to a greater extent than that of the minimum pocket volume, and that (3) these said rotary valves are balanced, *i.e.* the centrifugal force of one equals the centrifugal force of the other, and by virtue of these running in opposite directions, the two forces are balanced, and that (4) the incoming charge is given direction by the cooler gap or recess of the aforesaid inlet rotary valve before it impinges on any hot spot other than where it is required to impinge for the most efficient running of the engine, that is, on the head and stem of the aforesaid poppet valve or valves, and that (5) the exhaust gases do not impinge directly on the rotary valve controlling the exhaust function, thus permitting of a free exhaust and the elimination of any undue heating of the said rotary valve. The exhaust gases are never in contact with the flat gap of the inlet rotor or any part of the inlet rotor casing during the exhaust function. In the case of engines of say 1250 c.c. per cylinder, more than one poppet valve may be used for controlling ports to and from the cylinder, if, by so doing, the volume of the actual and minimum pocket formed for the heads of these poppet valves be of less volume than would be the case were a single poppet valve used, for it is a mathematical fact that the lip efficiency of one poppet valve is less than the lip efficiency of multiple poppet valves which are used for performing the same function as one poppet valve.

The foregoing description applies to a single cylinder engine cooled by air, oil, water or other means or to an engine cooled by air, water, oil or other means having two or more cylinders cast or constructed separately. In the case of an engine cooled by air, water, oil or other means having two or more cylinders cast or constructed "*en bloc*", the axes of such rotary valves will preferably be in a plane which is parallel to the engine shaft, in which case they may be constructed singly and suitably connected the one with the other, or two or more may be integrally constructed with a common axial centre line, and a series of these integral construction of such rotary valves may be suitably connected with other series of the same, while if the axes of such rotary valves are at right angles, or at any other angle to the engine shaft, then one inlet or one exhaust rotor may control respectively the inlet or exhaust functions of two adjacent cylinders, and such rotary valves will preferably be constructed singly, working together in every case with a poppet valve or valves for controlling the port or ports to and from each cylinder, the whole being so arranged and suitably operated that the pocket formed for the head of the aforementioned poppet valve or valves, has the minimum possible volume, and that any ducts or passages for induction and exhaust between the port or ports to and from the cylinder and the ports to the inlet and exhaust passages are entirely eliminated by virtue of these ports being incorporated in the actual pocket wall.

In direct communication with the cylinder at the end where exhaust and induction takes place, are valve casings consisting of a casting adapted to be secured by bolts, studs, or other suitable means to the end of the cylinder, incorporating preferably the combustion chamber or a part thereof, and comprising the port or ports to and from the cylinder, a pocket formed for the head of the previously mentioned poppet valve or valves, and directly in the wall of which minimum pocket are situated the exhaust port and the induction port which gives access where rotary valves are used to two housings or circular seatings formed for the accommodation of the previously mentioned rotary valves, and a seating or seatings for the poppet valve or valves, and also a guide or guides for the said poppet valve or valves. The said poppet valve or valves is or are suitably operated at the proper times by a rocking lever or levers acted upon by any convenient type of cam or cams, and though we have shown a surface cam, we do not commit or confine ourselves to this particular type, and the cam or cams may or may not be conveniently mounted on the spindle of one or more of such rotary valves. The whole, together with such rotary valves is conveniently driven and operated by any suitable gear or gearing from the driving shaft of the engine or in any other convenient manner.

When such rotary valves are used, a portion is cut away from the body of each of such rotary valves of necessary

width to give free passage to the gases, and of a suitable segmental depth that, by reason of their rotary motion, they give the required period of opening and closing to their respective ports. Such rotary valves are preferably of hollow open-ended D-section, in which hollow D section a suitable vane or vanes may or may not be incorporated, and an air scoop may also be incorporated on one end of each rotor, that by virtue of their rotary motion induces air to pass through the hollow D section longitudinally for internal cooling purposes. Suitable bearings are provided for the spindles of such rotary valves, in such a way that such rotary valves are held clear of their respective casings in which they revolve, these bearings shall preferably be mounted in the casting on suitably gapped pedestal housings, thereby restricting the possible heat path to the bearings and also allowing a flow of air, induced by the vaning and scoop, around and under each bearing and through such rotary valves. Toward the outer ends of each of such rotary valves, a suitable form of packing, which may preferably be one or more spring rings, shall be incorporated, in order that air may not be drawn past the outer ends of such rotary valves during the suction stroke of the cycle.

In order that our invention may be properly understood and readily carried into effect, we have hereunto appended two sheets of drawings illustrating one form of rotary valve, but it is to be understood that when the term rotary valve is used any form of such may be employed of which

Figure 1 shows a vertical section of so much of an internal combustion engine as is necessary in order that the application of our invention thereto may be shown as applied to rotary valves controlling the inlet and exhaust passage ports. In the position shown, the exhaust stroke has just ended, and the induction stroke is about to commence, and the figure illustrates how the dead or inert gas space is not increased between the exhaust and induction strokes, and the entire elimination of all ducts or passages between the port to and from the cylinder and the ports to the inlet and exhaust passages.

Figure 2 is a longitudinal section through the centre line of the pocket formed for the accommodation of the poppet valve or valves.

Figure 3 is an outside end view showing the ballrace bearings in their pedestal housings.

Figure 4 is an outside plane view.

Figures 5 and 6 are also vertical sections similar to Figure 1, but show respectively a position during the induction stroke, and a position during the exhaust stroke.

Figures 7 and 8 show respectively, an outside view of such a rotary valve and a transverse section through the line X Y of such a rotary valve.

Figure 9 shows an outside view of an integral construction of such rotary valves with their bearings.

In the construction according to our invention there are in direct communication with the cylinder A at the end where exhaust and induction takes place, valve casings consisting of a casting B, in which is preferably incorporated part or whole of the combustion chamber J, the whole being adapted to be secured by bolts, studs or other suitable means marked *b* to the end of the cylinder A, and comprising a port C to and from the cylinder A, the pocket D formed for the head of a poppet valve E, the exhaust port F and the induction port G, and also two housings or circular seatings *h* and *k* for such rotary valves H and K, and a seating *e* for a poppet valve E, and a guide *l* for the stem L of the poppet valve E. Such rotary valves H and K with the ports G and F which they control are arranged and operated as close as is practicable to the stem L of the said poppet valve E and to the port C, in order that the volume of the said pocket D formed for the accommodation of the head of the poppet valve E shall be at its minimum and that all passages or ducts between the port C to and from the cylinder A and the port G to the inlet passage and the port F to the exhaust passage are entirely eliminated, by virtue of the parts F and G being incorporated in the actual wall of the said pocket D, and also to effect a better scavenge and avoid direct impingement of the hot gases on such a rotary valve K because at the period of exhausting such a rotary valve K is in such a position that its gapped face avoids the direct impingement of exhaust gases. In operation the poppet valve E is opened by an operating lever O pivoted at P and acted upon by a cam Q which is shown mounted on the axis of such a rotary valve K. Such rotary valves H and K are driven by any suitable gear from the driving shaft of the engine such as a shaft R, mounted on which is the gear wheel T meshing with the gear wheels S and T, these being suitably mounted and secured on the axes of such rotary valves H and K. The poppet valve E is closed by the action of a spring V upon a collar

piece *v* attached to the stem L. Such rotary valves H and K are of hollow open ended "D" section, as shown by W, in which "D" section may preferably be constructed suitable vanes *w* and at one end of such rotary valve may be an air scoop w^1. The spindles of such rotary valves H and K are carried in bearings M and these bearings are preferably mounted in the casting B on pedestal housings N, having gaps N^1 in order that the heat path to these said pedestal bearings may be restricted and that air may be induced by the vaning *w* and the scoop w^1 through gaps N^1 in the aforesaid housings N for the said bearings M, and through the hollow "D"-section W. In order that air may not be drawn past the outer ends of such rotary valves H and K during the suction stroke of the engine, such rotary valves which have their axes preferably parallel to the engine shaft, are provided at each of their ends with packing rings *x*.

The invention can be employed in engines having one or more than one cylinder and in the case of two or more cylinders being constructed *en bloc* Figure 9 illustrates an integral construction of such rotary valves which it is preferred will be employed in connection with other integral constructions of the same, and the axes of such rotary valves will preferably be parallel to the engine shaft.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. In valvular arrangements of internal combustion engines of the kind set forth the construction by which all gas passages or ducts between the poppet-valve controlled port or ports to and from the cylinder and the ports to the inlet and exhaust passages are entirely eliminated by virtue of the induction and exhaust ports being incorporated in the actual wall of the minimum pocket formed for the accommodation of the head of the aforesaid poppet valve or valves, substantially as and for the purposes hereinbefore described.

2. In valvular arrangements of internal combustion engines of the kind set forth valve casings consisting of a casting adapted to be attached to the end of the cylinder where admission and exhaust take place, the said casting comprising part or whole of the combustion chamber, the induction port, the exhaust port, and the port to and from the cylinder with which the two aforementioned ports have direct communication, there being two circular seatings one on either side and as close as possible to the port to and from the cylinder for two rotary valves whose axes are in a plane parallel with the shaft of the engine, and a seating or seatings for a poppet valve or valves, which controls the port or ports to and from the cylinder, and a guide or guides for the stem of the said valve or valves, all being arranged substantially as and for the purposes hereinbefore described and illustrated.

3. In valvular arrangements of internal combustion engines as claimed in Claim 2, the arrangement of the directions of rotation of the rotary valves in such a manner that (*a*) the flat faces of these rotary valves permit of no increase in the volume of the residual gas space above the port to and from the cylinder between the exhaust and induction functions, that (*b*), the hot gases do not directly impinge on the rotary valve controlling the exhaust functions and that (*c*), the aforesaid rotary valves are balanced, substantially as and for the purposes hereinbefore described and illustrated.

4. In valvular arrangements of internal combustion engines as claimed in Claim 3, the provision of hollow section open ended rotary valves incorporating internal cooling vanes and an air scoop to induce a draft of air through the rotary valves, substantially as and for the purposes hereinbefore described and illustrated.

5. In valvular arrangements of internal combustion engines as claimed in Claim 2, the arrangement of bearings on the spindles of the aforesaid rotary valves, and pedestal housings for the said bearings, and means for allowing for the passage of air through and around the said pedestals substantially as hereinbefore described, and illustrated in Figures 2 and 3 of the accompanying drawings.

6. In valvular arrangements of internal combustion engines as hereinbefore described and claimed an integral construction of two or more rotary valves with a common axial centre line, substantially as and for the purposes hereinbefore described and illustrated.

Dated this 10th day of February, 1923.

JOHN LIDDLE,
154, St. Vincent Street, Glasgow,
Chartered Patent Agent.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1923.

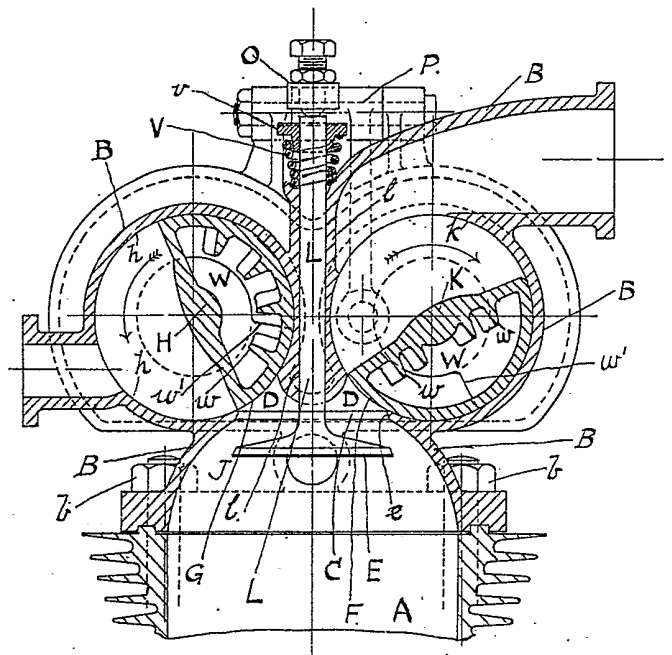

FIG. 1.

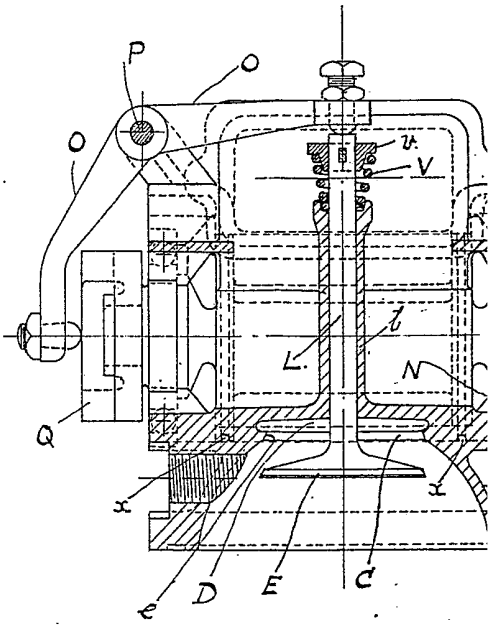

FIG. 2.

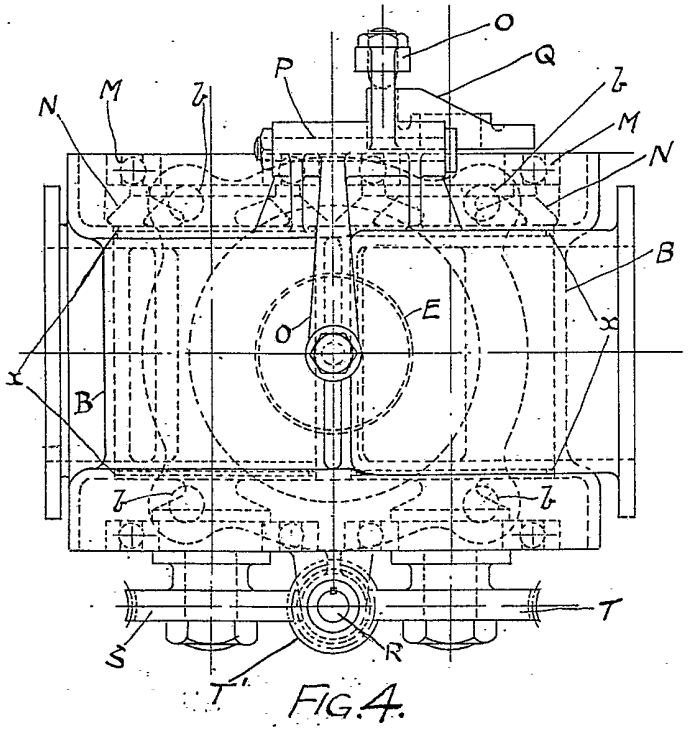

FIG. 4.

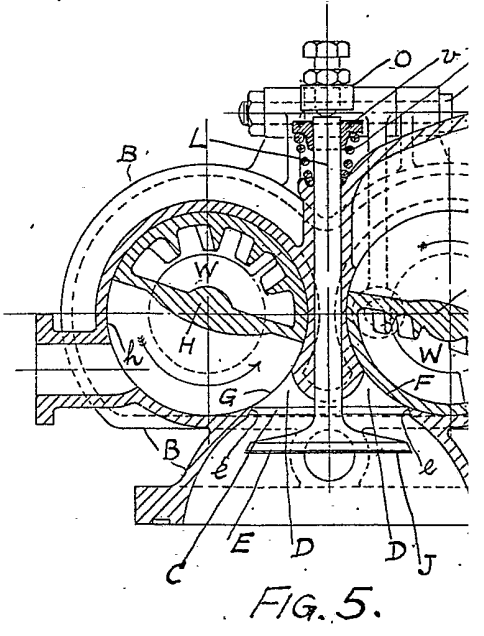

FIG. 5.

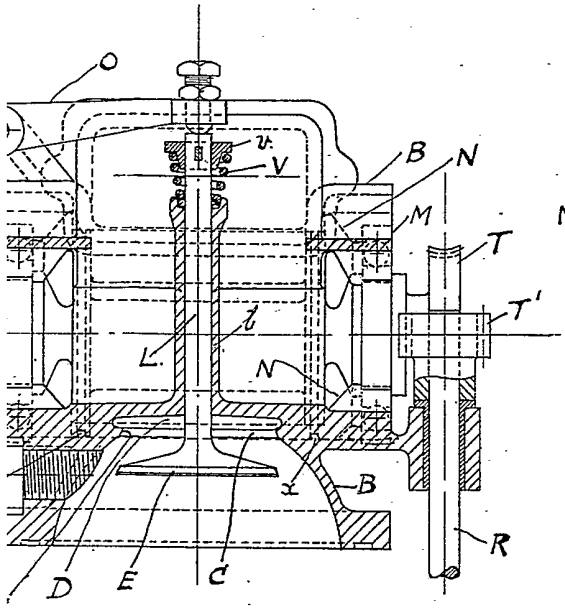

FIG. 2.

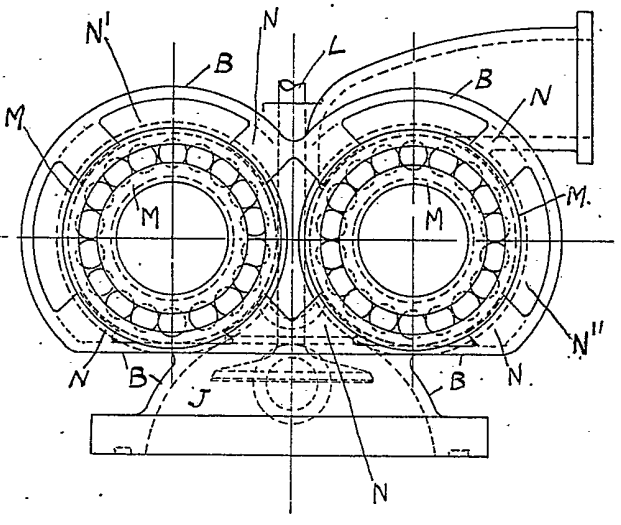

FIG. 3.

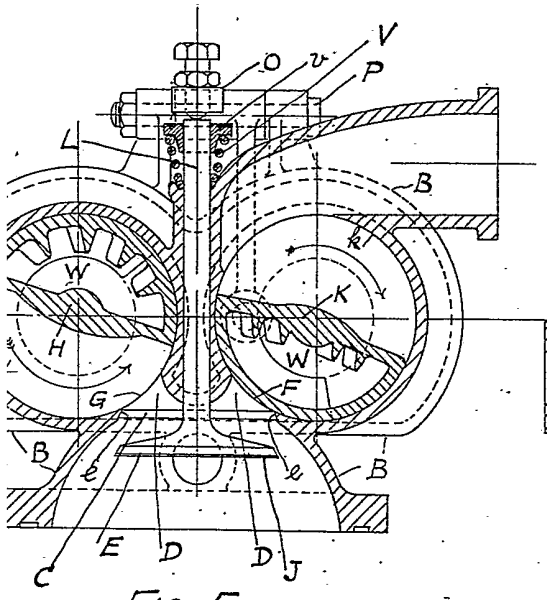

FIG. 5.

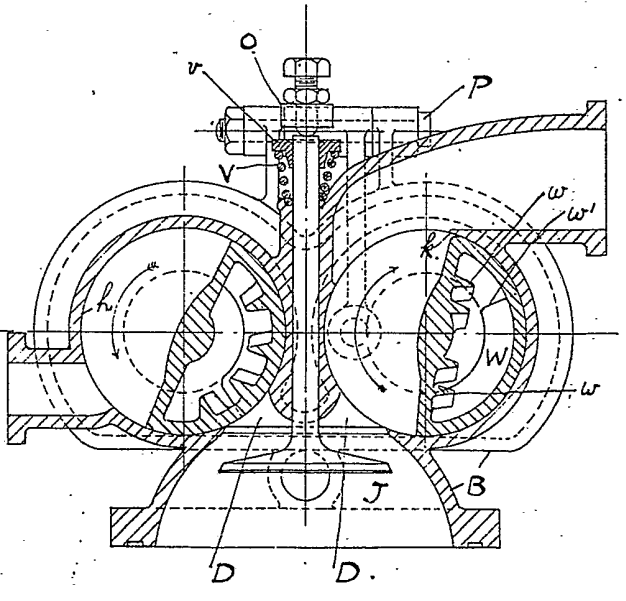

FIG. 6.

Malby & Sons, Photo-Litho

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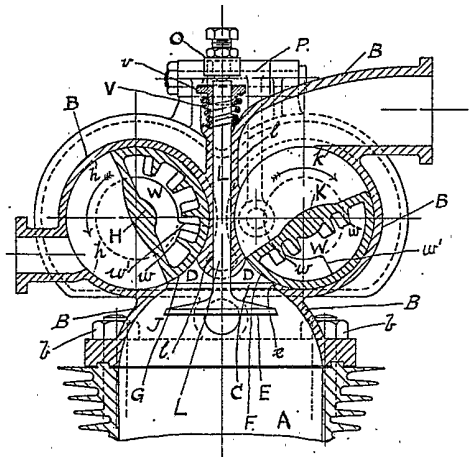

FIG. 1.

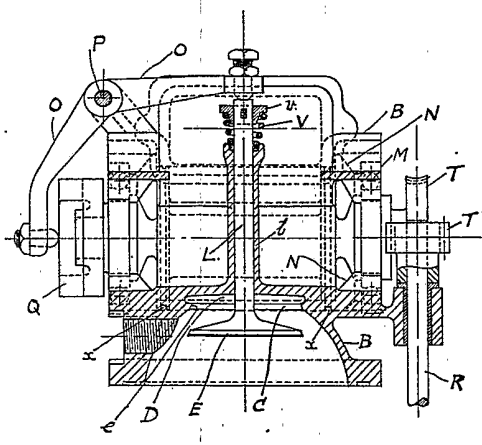

FIG. 2.

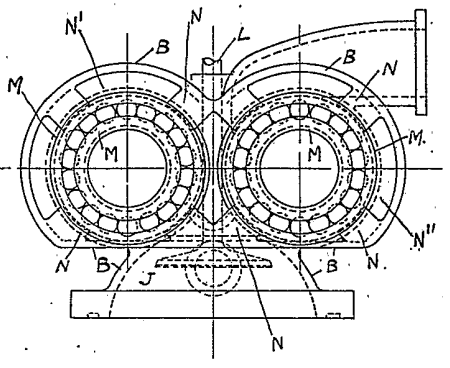

FIG. 3.

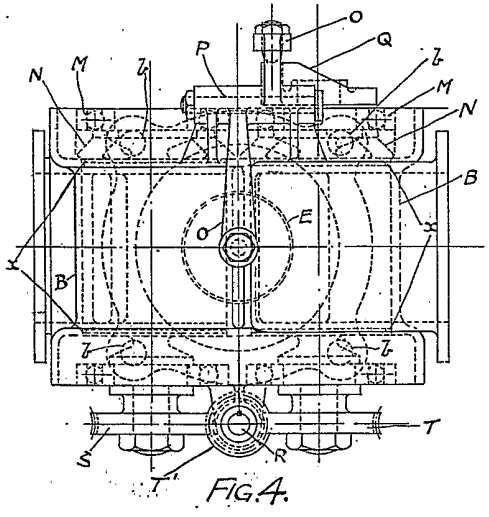

FIG. 4.

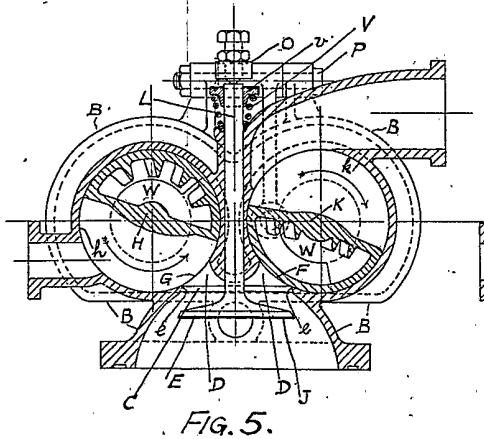

FIG. 5.

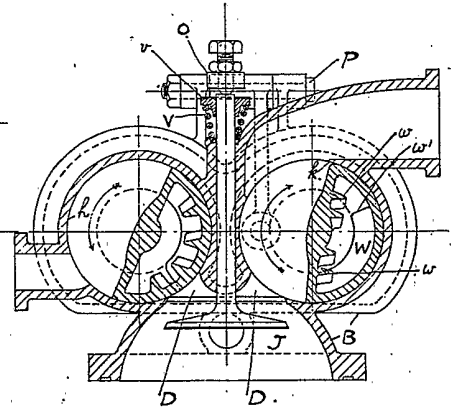

FIG. 6.

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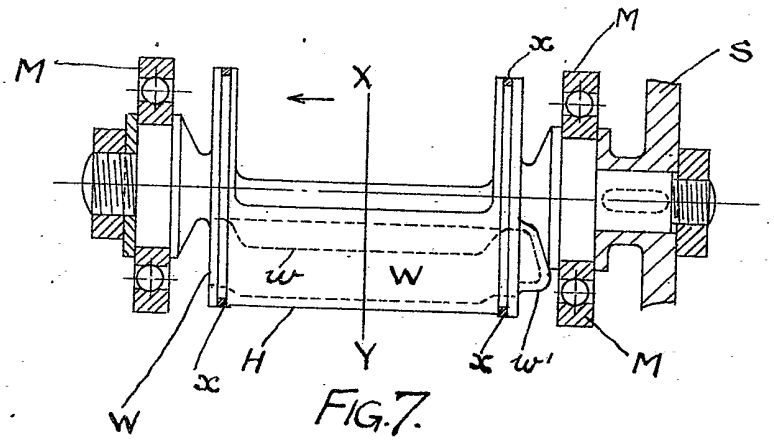

FIG. 7.

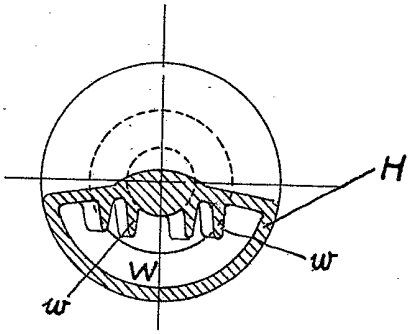

FIG. 8.

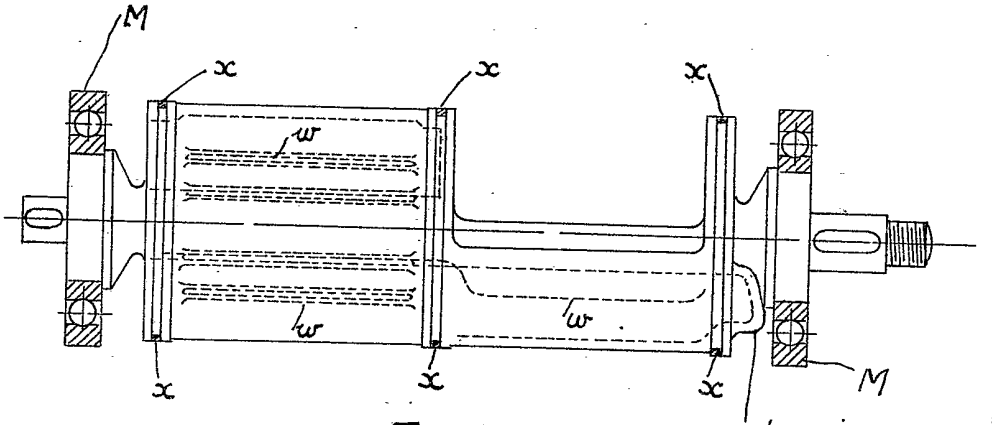

FIG. 9.

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