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PROVISIONAL SPECIFICATION.

Improvements in or relating to Reversible Internal Combustion Engines.

I, FREDERICK LAMPLOUGH, of 53a, Pall Mall, London, S.W., Consulting Engineer, do hereby declare the nature of this invention to be as follows:—

This invention is for improvements in or relating to reversible internal combustion engines and will be described with reference to the two-stroke cycle type of engine wherein twin cylinders are employed connected at one end by a combustion-chamber common to both and having an "inlet" port uncovered by one of its pistons and an "exhaust" port uncovered by the other piston. The connecting-rods of the two pistons are coupled to the same crank but one is situated in a vertical plane on one side of the crank-shaft and the other in a vertical plane on the other side. The inlet and outlet ports are at the same level in the cylinder and the effect of coupling the two pistons to the same crank in this manner is that the movement of the crank enables the proper lead to be given to the exhaust both when opening and closing, as the two pistons do not travel synchronously at all points.

It has not been proposed before to make an engine of this type reversible and although it is preferred to use the present invention as applied to this type of engine it will be understood that the invention is not restricted thereto, the reference to the same throughout the specification being by way of example and not by way of limitation.

According to the present invention there is employed in a reversible internal combustion engine means (for example a two-way valve) for connecting the charge-supply conduit to the "inlet" or "exhaust" port of the engine as required two ignition mechanisms one adjusted for "forward" and the other for "reverse" running, and means for bringing either ignition mechanism into operation as required, so that as the function of the ports is changed for changing the direction of running of the engine the ignition mechanism is also adjusted to suit the change in rotation of the crank-shaft.

When the crank-chamber is employed as a pump-chamber and positively operated valve-mechanism is used to control the "inlet" and discharge ports of this chamber, means (for example a two-way valve) may be employed whereby the conduit leading to the carburettor is connected to either port of the crank-chamber as required, so that as the function of the ports is changed by reversing the engine a corresponding change of connection to the carburettor may be effected.

The valve mechanism for controlling the said ports in the crank-chamber may be so arranged that whichever way the engine runs the opening of the ports will be correct though the function of the respective ports will be changed. For example the valve may take the form of a ring mounted concentric with the crank-shaft and having a gap which enables it to be introduced after the crank-shaft is in place, said gap serving as the port in the valve

to uncover ports in the wall of the crank-chamber as the valve is driven by a projection from the crank-shaft

Where a compressed-air starter is employed the distributor may be provided with means whereby its angular position may be changed relatively to its driving member for reverse running.

According to one method of carrying out this invention the engine is provided with four twin-cylinders arranged with their piston-rods and cranks as set forth in the type above referred to, two of the twin-cylinders being conveniently enclosed in one water-jacket and the other two in another water-jacket, the arrangement being such that each twin-cylinder is set across the crank-shaft so that one piston of all the twin-cylinders will lie to one side of the crank-shaft and the other pistons will all lie on the other side of the crank-shaft.

The ports on one side of the engine, which for convenience will be called the "inlet" ports, although for the present invention they perform both functions according to the direction of running of the engine, all open into a conduit which extends along one side of the engine and bends round at the end to meet a charge-supply conduit. The "exhaust" ports all open into a conduit on the opposite side of the engine which similarly runs along the said side and is bent round at the end to meet the "inlet" conduit and also the charge-supply conduit. A fourth or discharge conduit, which in some cases may not be more than an opening, communicates with the "inlet" and "exhaust" conduits at a point opposite the charge-supply conduit so that these four conduits meet together in the form of a cross. This arrangement permits a rotary-valve in the form of a sleeve having a diagonal internal partition and side ports, one on one side of said partition and one on the other, to be mounted in the ends of the "inlet" and "exhaust" conduits between the charge-supply and discharge conduits. The valve is provided with an operating spindle which extends out through the end of the bends, say of the "exhaust" conduit, where it is provided with a sprocket for rotating it.

It will be seen that this arrangement enables either the "inlet" or the "exhaust" conduit to be put in communication with the discharge conduit or alternatively with the charge-supply conduit so that by turning the valve one way or the other the "inlet" ports of the engine may be instantly transformed into "exhaust" ports and the "exhaust" ports into "inlet" ports.

The crank-chamber is divided by transverse partitions so that the portion allotted to each twin-cylinder is self-contained and has its own "inlet" and discharge ports. These ports are controlled by a ring-valve mounted concentrically with the crank-shaft. The valve is cut away on one side so that a gap is provided which enables it to be introduced into place after the crank-shaft is in place, the gap being wide enough to admit the crank-shaft through it. This gap serves as the port in the valve and the valve is driven from the crank-shaft so that the gap is brought to register with each port in the crank-chamber in turn and thus effects the requisite control of the admission and discharge.

The "inlet" ports of the crank-chamber compartments are connected by passages to a vertical external conduit conveniently arranged at one side of the engine and midway along the same so that it lies between the two pairs of twin-cylinders and the discharge ports are connected to a similar conduit on the other side of the engine. These conduits bend over to meet each other above the engine and are joined by a carburettor conduit on one side and an air-conduit, which may take the form of an outlet only, on the other side. These four conduits thus again form a cross so that a rotary-valve similar to that already described can be mounted in the ends of the "inlet" and discharge conduits and between the air-conduit and the carburettor conduit for the purpose of connecting either the "inlet" or discharge conduit to the carburettor conduit or to the air-conduit as required. The valve is provided with a spindle which extends out beyond one of the conduits and carries a sprocket which sprocket is connected by a chain to that of the other valve.

It will be appreciated that if the engine is to be reversed the adjustment of the ignition must be changed to suit the reverse running and for this purpose two separate magneto-mechanisms are provided, adjustment for one being for "forward" running and the other for "reverse" running. A clutch operates between them to connect either with the magneto driving-shaft for operating it. This clutch may be operated from one arm of a rocking-lever which receives motion from an eccentric mounted on the spindle of one of the rotary valves so that when the valves are set the proper magneto-mechanism will also be thrown into operation.

Owing to the type of engine which has been selected for describing the invention each magneto must be connected to its own series of ignition plugs, those of one magneto being mounted in the half of the twin-cylinders on one side of the crank-shaft and those of the other magneto being mounted in the half cylinders on the other side of the crank-shaft.

Conveniently the engine is started with compressed air and for this purpose a distributor is employed which may take the form of a disc driven from the engine and having a port which is brought to register in proper turn with an auxiliary valve provided in each cylinder for the admission of the compressed air at starting. It will be appreciated that if the engine is reversed this disc will require to have its angular relation to its driving-shaft changed in order that it may synchronise with the change of order of operation of the cylinders. To effect this adjustment of the disc the latter is driven from the engine by spiral-gearing and one element of the gearing is arranged to be movable (say along its axis of rotation) relatively to the other so that by this movement the disc may be angularly displaced relatively to its driving shaft. To move the said spiral gear-wheel the latter may be provided with a collar which is engaged by a fork operated from the same rocking-lever which operates the clutch for the magneto-mechanism.

From the above it will be seen that all the parts of the engine which need to be re-adjusted for reverse running are operated from the one controlling member so that the operator has nothing to consider except the position of the said single member.

If there is employed with the engine a lubricant or water-circulating pump of the type which reverses its discharge when its driving shaft is reversed some means is necessary for counteracting this.

A further feature of the present invention therefore consists in providing a suction conduit for the pump which conduit has two branches communicating respectively with the "inlet" and discharge ports of the pump each branch being controlled by a valve which prevents liquid from passing through it from the pump, and a discharge conduit also having two branches which again communicate respectively with the two ports of the pump but are controlled by valves which prevent flow through them towards the pump. It will be seen that such an arrangement may be added to any known form of pump and will ensure that when the driving-shaft of the pump is reversed the delivery will always take place in the same direction although in the pump itself the flow has been reversed.

It will be appreciated that although some of the features described above apply only to the particular type of engine with which the invention has been described, or to an engine having a particular type of valve employed in the crank-chamber, yet other features apply to internal combustion engines generally.

Dated this 12th day of February 1915.

BOULT, WADE & TENNANT,
111 & 112, Hatton Garden, London, E.C.,
Chartered Patent Agents.

COMPLETE SPECIFICATION.

Improvements in or relating to Reversible Internal Combustion Engines.

I, FREDERICK LAMPLOUGH, of 53a, Pall Mall, London, S.W., Consulting Engineer, 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 :—

This invention is for improvements in or relating to reversible internal combustion engines and will be described with reference to the two-stroke cycle type of engine wherein twin cylinders are employed connected at one end by a combustion-chamber common to both and having an "inlet" port uncovered by one of its pistons and an "exhaust" port uncovered by the other piston and wherein the connecting-rods of the two pistons are coupled to the same crank but one is situated in a vertical plane on one side of the crank-shaft and the other in a vertical plane on the other side. The inlet and outlet ports are at the same level in the cylinder and the effect of coupling the two pistons to the same crank in this manner is that the movement of the crank enables the proper lead to be given to the exhaust both when opening and closing, as the two pistons do not travel synchronously at all points.

It has not been proposed before to make an engine of this type reversible and although it is preferred to use the present invention as applied to this type of engine it will be understood that the invention is not restricted thereto, the reference to the same throughout the specification being by way of example and not by way of limitation.

According to the present invention there is employed in a reversible internal combustion engine, means (for example a two-way valve) for connecting the charge-supply conduit to the "inlet" or "exhaust" port of the engine as required, two ignition mechanisms one adjusted for "forward" and the other for "reverse" running, and means for bringing either ignition mechanism into operation as required, so that as the function of the ports is changed for changing the direction of running of the engine the ignition mechanism is also adjusted to suit the change in the rotation of the crank-shaft.

When the crank-chamber is employed as a pump-chamber and positively operated valve mechanism is used to control the "inlet" and "discharge" ports of this chamber, there may be combined with the parts set forth in the preceding paragraph a second valve (for example a second two-way valve) for connecting either port of the crank chamber to a conduit leading to the carburettor as required and a change-over member operatively connected with both of these valves for moving them simultaneously so that a single movement re-sets the whole conduit-system for reverse running.

It has previously been proposed to use two-way valves in internal combustion engines to interchange the functions of the exhaust and inlet ports for reversing the engine. Also in a two-cycle reversible engine it has been proposed to use a two-way valve in connection with a charge-pump in order that it might deliver mixture to the engine whatever the direction of running. Such means are therefore only claimed herein in the combinations set forth.

The valve mechanism for controlling the said ports in the crank-chamber may be so arranged that whichever way the engine runs the opening of the ports will be correct though the function of the respective ports will be changed. For example the valve may take the form of a ring mounted concentrically with the crank-shaft and having a gap which enables it to be introduced after the crank-shaft is in place, said gap serving as the port in the valve

to uncover ports in the wall of the crank-chamber as the valve is driven by a projection from the crank-shaft.

Where a compressed-air starter is employed the distributor may be provided with means whereby its angular position may be changed relatively to its driving member for reverse running.

In the accompanying drawings which illustrate one method of carrying out this invention:—

Figure 1 is a side-elevation of a four-cylinder engine with some parts in section for the sake of clearness;

Figure 2 is a section through the engine on the line 2—2 of Figure 1;

Figure 3 is a section through the engine on the line 3—3 of Figure 1;

Figure 4 is a face view of a detail, and

Figure 5 is a section through a detail.

The same letters indicate the same parts throughout the drawings.

The engine shown in the drawings is provided with four twin-cylinders A the elements of which are each separated by a central wall A^1 on opposite sides of which two pistons A^2 A^3 are disposed. All the pistons A^2 lie to one side of a vertical plane passing through the crank-shaft B, and the pistons A^3 lie to the other side of the said vertical plane. Both pistons are connected to the same crank by rods B^2 and B^3 respectively, the rod B^3 being pivoted to the rod B^2 at B^1.

Each twin-cylinder has what for convenience may be termed an "inlet" port A^4 on one side of the central wall A^1 and an "exhaust" port A^5 on the other side. These ports can as a matter of fact be used for either exhaust or inlet as will be hereinafter described, according to the direction in which the engine is being run.

The "inlet" ports of the different cylinders all communicate with a conduit C which extends along one side of the engine, and the "exhaust" ports all communicate with a conduit D which extends along the other side of the engine. The "inlet" and "exhaust" conduits are bent round at one end of the engine to meet one another (Figure 3), and at the meeting point they form a T with a charge-supply conduit E, and, situated opposite this, is an outlet conduit D^1. The meeting ends of the conduits C, D, and the conduits D^1 and E are arranged in the form of a cross constituting a four-way conduit system, and at the crossing point is mounted a two-way rotary-valve F. This valve is in the form of a sleeve having oppositely arranged ports F^1, F^2 divided by an internal diagonal diaphragm F^3. The ports are arranged to register one with the conduit D^1 and the other with the conduit E according to the position of the valve, and extending from the valve is a spindle F^4. This is carried out through the bend of the conduit D and outside the said conduit has mounted on it a sprocket-wheel F^5.

The conduit E is connected at its other end to a carburettor-chamber E^1 which is supplied with air by a conduit E^2. The conduit E^2 has two branches E^3, E^4 which extend in opposite directions from the said conduit and communicating with these branches at a point opposite the conduit E^2 is an air-inlet conduit E^5. These conduits together form another four-way system and a two-way valve G is mounted at the crossing point of the conduits. The valve has side ports G^1 and G^2 which are separated by a diagonal diaphragm G^3 within the valve. Extending from the valve and through the wall of the branch conduits E^3 E^4 is a spindle G^4. On one end of this spindle is a hand-wheel G^5 and on the other end is a sprocket-wheel G^6. The sprocket-wheels G^6 F^5 are connected together by a chain F^6.

The crank-chamber of the engine is divided into separate compartments by a series of hollow transverse partitions whereof one is shown at H, Figures 1 and 3, and the interior of each partition is divided by internal partition-pieces H^1 into separate compartments H^2 and H^3 respectively. The compartment H^3 communicates by a port H^4 with the conduit E^3, and the compartment H^2 communicates through a port H^5 with the conduit E^4. One of these partitions H is placed

between the crank-chamber of one twin-cylinder and that of the next of that pair so that the portion of the crank-chamber beneath each twin-cylinder can be used as a pump-chamber. For this purpose each hollow partition is provided with ports H^{5*}, H^6 in its sides, one serving the chamber H^2 and the other the chamber H^3, and these ports are controlled by a ring-valve H^7 (Figures 1 and 4) which lies in an annular channel formed in the face of a housing for the valve which housing is secured in the partition H. The ring-valve is cut away at H^8 to enable it to be inserted after the crank-shaft B is in place, and the cut-away portion constitutes the port through the valve. The valve is driven by a pin H^9 fixed in the counterbalance-weight B^3 of the crank-shaft and is kept up to its work by springs H^{10} placed between it and the balance-weight. It will be seen from this description that the valve H^7 positively controls the ports H^{5*}, H^6 and always moves synchronously with the crank-shaft with which it is in positive engagement.

The operation of this part of the engine with the valves F and G set as shown in Figure 3 is as follows:—

During the up-stroke of the pistons A^2, A^3, the gap H^8 in the valve H^7 uncovers the port H^6 so that air is drawn into the crank-chamber through the conduit E^5, port G^2 in the valve G, conduit E^3, port H^4 in the chamber H^3 of the hollow partition H, and port H^6 in the wall of the partition. During the down-stroke of the pistons, the port H^6 is covered by the valve H^7 and the port H^{5*} uncovered so that the air is discharged into the chamber H^2 of the hollow partition and through the port H^5 thereof into the conduit E^4 whence it passes to the carburettor-conduit E^2 and through the carburettor E^1 into the charge-supply conduit E. From this conduit it passes into the induction-conduit C by the port F^1 of the valve F, and thence to the inlet-ports A^4 of the engine-cylinders.

The exhaust takes place through the conduit D and port F^2 in the valve F to the outlet-conduit D^1, whence it may either escape into the atmosphere or pass to a silencer.

With this arrangement of parts and order of operation, it will be seen that by turning the hand-wheel G^5 which serves as a change-over member for reversing the engine, the valves F and G may be rotated so that the port F^2 of the valve F puts the charge-supply conduit into communication with the conduit D instead of the conduit C and the port F^1 puts the outlet-port D^1 into communication with the conduit C. Similarly the port G^2 of the valve G will put the carburettor conduit E^2 into communication with the conduit E^3 instead of the conduit E^4, and the port G^1 will put the air-supply conduit E^5 into communication with the conduit E^4. By this means the function of the various conduits is reversed so that the conduit C becomes the exhaust-conduit and the conduit D the induction conduit, and the air supplied to the crank-chamber enters by the port H^{5*} instead of the port H^6, and is discharged by the port H^6 to the carburettor-conduit E^2. So far as the arrangement of the conduits therefore is concerned, the engine will run equally well in either direction, the particular direction at any time depending only upon positioning the valves F and G.

Each partition H has ports on both sides of it and a ring-valve, one on each side, so that it serves the two adjacent crank-chambers, and the cylinders are set together in this manner in pairs each pair conveniently being embraced in a single water-jacket; a partition having no crank-chamber ports is provided between the crank-chambers of one pair of cylinders and the next. The ports H^4 H^5 of each of the partitions H open into two passages, which are in communication with the conduits E^3 E^4 and thus connect all the pump chambers with these conduits.

As is well-known, the timing of the ignition requires adjustment if an engine is to be reversed and for this purpose two separate magneto mechanisms J, J^1 are provided, one timed for forward running and the other for reverse running, and connected one to a sparking-plug situated at A^6, Figure 2, and the other with a sparking-plug situated at A^7, Figure 2. The object of having two sparking-plugs

is that the plug always in use may be near the inlet so as to ensure ignition of the charge when the engine is being throttled. Consequently the ignition plug A^6 will be used when the conduit C is employed as the induction conduit, and the sparking-plug A^7 when the conduit D is employed as the induction conduit.

The ignition mechanism is driven from a shaft J^2 which has mounted on it a gear-wheel J^3. This meshes with a wheel J^4 which is carried on a sleeve J^5 which is free to slide on a spindle J^6. The sleeve has clutch parts J^7, J^8 at its ends which can be brought into engagement with clutch parts J^9 and J^{10}. The clutch part J^9 is operatively connected to the magneto mechanism J^1 and the clutch part J^{10} to the magneto mechanism J. To move the wheel J^4 it is provided with a channelled collar J^{11} which in turn is engaged by a fork K. The fork is carried on a rock-shaft K^1 to which is secured an arm K^2 the end of which is connected by a link K^3 to an arm K^4 pivoted at K^5 to the frame of the machine. The arm K^4 is fast to a rod K^6 which slides in a sleeve K^7 having a head shaped to receive an eccentric K^8 on the spindle G^4 of the valve G. The head of the socket K^7 thus operates as an eccentric strap on the eccentric K^8 so that when the spindle G^4 is turned to set the valve G, the eccentric is correspondingly moved within the strap and rocks the socket K^7 to one side or the other of the centre of the spindle. In Figure 1 the socket is shown as rocked to the left so that the arm K^4 is depressed and the fork K is moved to the left to bring the magneto J into operative engagement with the wheel J^4. This is the correct position for the parts when the valves G and F are in the position shown in Figure 3, but when these are turned for reversing the engine, the socket K^7 is rocked to the right of the centre of the valve-spindle G^4 (as seen in Figure 1) and then the arm K^4 is raised and the fork K is swung to the right so that the magneto J^1 is brought into operation by engagement of the clutch part J^7 with the clutch part J^9 and the magneto J is thrown out of action by the clutch part J^8 being withdrawn from the clutch part J^{10}.

For starting the engine compressed air is employed. This is compressed by a pump L into the hollow partition in the crank-chamber which has been referred to as situated between the crank-chambers of the two pairs of cylinders. This hollow partition is not shown in the drawings, but it has no communication with the crank-chambers and is merely employed as a storage reservoir. The air therefrom is admitted to a distributor by a control-lever under the hand of the operator in the usual manner, and it will be appreciated that this distributor needs to be re-adjusted when the engine is reversed. The distributor is driven by a shaft indicated at L^1, but the distributor and other associated parts need no description in the present specification as they form in themselves no part of the present invention, the only mechanism relating thereto which does form a part of the invention being the driving means which connects the shaft L^1 to the shaft J^2. This comprises a spiral-toothed wheel L^2 mounted on the shaft J^2 and which meshes with a spiral-toothed wheel L^3 which is free to slide on a spindle L^4 mounted at right angles to the shafts J^2 and L^1. The gear L^3 is made fast on a sleeve L^5 which carries a second spiral-toothed gear L^6. The gear L^6 meshes with a spiral-toothed gear L^7 fast on the shaft L^1. The direction of the spiral of the teeth on the wheel L^3 is opposite to that of the teeth on the wheel L^6, that is to to say, if on the wheel L^3 the teeth constitute part of a right-handed screw, those on the wheel L^6 will constitute part of a left-handed screw.

Between the two wheels L^3, L^6, a collar L^8 is provided on the sleeve L^5. Pivoted at M is a lever M^1 one end of which is forked and engages the collar L^8; the other end is connected by a link M^2 to an arm M^3 which is conveniently made in one with the arm K^4 and pivots about the same centre K^5 so that as the arm K^4 is rocked by the rod K^6, the arm M^3 will also be rocked.

The object of this mechanism is to change the angular position of the distributor relatively to the crank-shaft of the engine when the engine is reversed, and it will be seen that if the rod K^6, as viewed in Figure 1, is rocked to the right as it will be when the wheel G^5 is turned to reverse the engine, the link M^2 will be thrust

down and the fork M^1 will be raised. As the fork rises, it will lift the wheels L^3 L^6 and the obliquity of the teeth of the two wheels being reversed, will necessitate that either the shaft J^2 or L^4 must be moved angularly. The shaft J^2 is positively connected with the crank-shaft and therefore cannot be moved so that as the sleeve L^5 with its wheels rises, the shaft L^1 will be angularly displaced and the parts are so proportioned that the movement given to the sleeve is just sufficient to re-adjust the distributor.

A water-circulating pump N and a lubricant-circulating pump O are provided. Each of these pumps is of a rotary type which, if reversed, would cause a reverse flow of the liquid pumped, so that means are provided for always directing the delivery from these pumps into the same channels. Where pumps are employed which do not reverse their delivery when the engine is reversed, no such means is required, but Figure 5, which is a section on the line 5—5 through the lubricant-pump O, Figure 1, shows the means adopted for maintaining the flow always in one direction.

The pump is provided with a suction-conduit O^1 having two branches O^2, O^3 which connect respectively with the inlet- and discharge-ports O^4 and O^5 of the pump. Non-return valves O^6, O^7 are provided at the ends of the branches O^2, O^3 to prevent any flow back through the suction-conduit O^1. The pump is also provided with a delivery-conduit O^8 having branches O^9 O^{10} which connect with the inlet- and discharge-ports O^4, O^5 and are provided with valves O^{11}, O^{12} which prevent any flow through the delivery-conduit in the direction of the pump. Although O^4 has been called the inlet-port and O^5 the discharge-port, it will be appreciated that when the direction of drive of the pump is reversed, O^5 becomes the inlet-port and O^4 the discharge-port, but whichever function either port is performing, it will be seen that lubricant must always be sucked through the conduit O^1 and be delivered through the conduit O^8, though if the port O^5 is serving as the inlet-port, it will be sucked through the branch O^9 instead of the branch O^2 and discharged through the branch O^9 instead of the branch O^{10}. This is a simple arrangement of conduits and valves which can be applied to any form of pump whose direction of discharge is reversed when the direction of drive is reversed and as it is entirely automatic it needs no controlling connection with the operating-handle G^5. The operating-handle is the only member which has to be moved to effect the reversal of the engine except the necessary operation of the control-levers for stopping the engine prior to reverse, and re-starting it.

It will be appreciated that although some of the features described in this specification apply only to the particular type of engine with which the invention has been described, or to an engine having a particular type of valve employed in the crank-chamber, yet other features apply to internal combustion engines generally.

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

1. In a reversible internal combustion engine, the combination with a change-over member and a valve (for example a two-way valve) operated thereby for connecting the charge-supply conduit to the "inlet" or "exhaust" port of the engine as required, of two ignition-mechanisms one adjusted for "forward" and the other for "reverse" running and means for bringing either ignition mechanism into operation as required for the purpose described.

2. In a reversible internal combustion engine the combination with the parts set forth in claiming-clause No. 1 of a second valve (for example a second two-way valve) for connecting either port of the crank chamber to a conduit leading to the carburettor as required and a change-over member operatively connected with both of these valves for moving them simultaneously for the purpose described.

3. A reversible internal combustion engine according to claiming-clause No. 2 wherein the positively operated valve-mechanism for the crank-chamber takes the

form of a valve (for example the ring-valve H^7) which is so arranged to control the ports in the said crank-chamber that whichever way the engine runs the opening of the ports will be correctly timed though the function of the respective ports will be changed.

4. In a reversible internal combustion engine the combination with the parts set forth in claiming-clause No. 1 of a distributor for a compressed air starter and means operatively connected with the change-over member to change the angular position of the distributor for reverse running when the valves are changed.

5. In a reversible internal combustion engine according to claiming-clause No. 4 the employment of spiral gearing (L^7) for driving the distributor, one wheel (L^6) of the spiral gearing being movable (say along its axis of rotation) relatively to the other in such direction as to draw its teeth along between those of the other, the means for so moving it being moreover operatively connected to the change-over member so that when the position of the valves is changed the angular position of the one spiral-gear-wheel relatively to the other is changed and the distributor consequently is correspondingly re-positioned.

6. A reversible internal combustion engine according to claiming-clause No. 1 wherein a clutch is provided to effect driving-connection between the magneto-driving shaft and one or the other of the two magnetos said clutch being moreover operatively connected with the "change-over" member so as to be moved with it.

7. In an internal combustion engine of the type described but being reversible by having the parts set forth in claiming-clause No. 1, the provision of two sparking-plugs, one in one element of the twin-cylinders and the other in the other element, one plug being connected with the "forward" sparking-mechanism and the other with the "reverse" sparking mechanism for the purpose described.

8. The reversible internal combustion engine substantially as described or illustrated in the accompanying drawings.

Dated this 14th day of July 1915.

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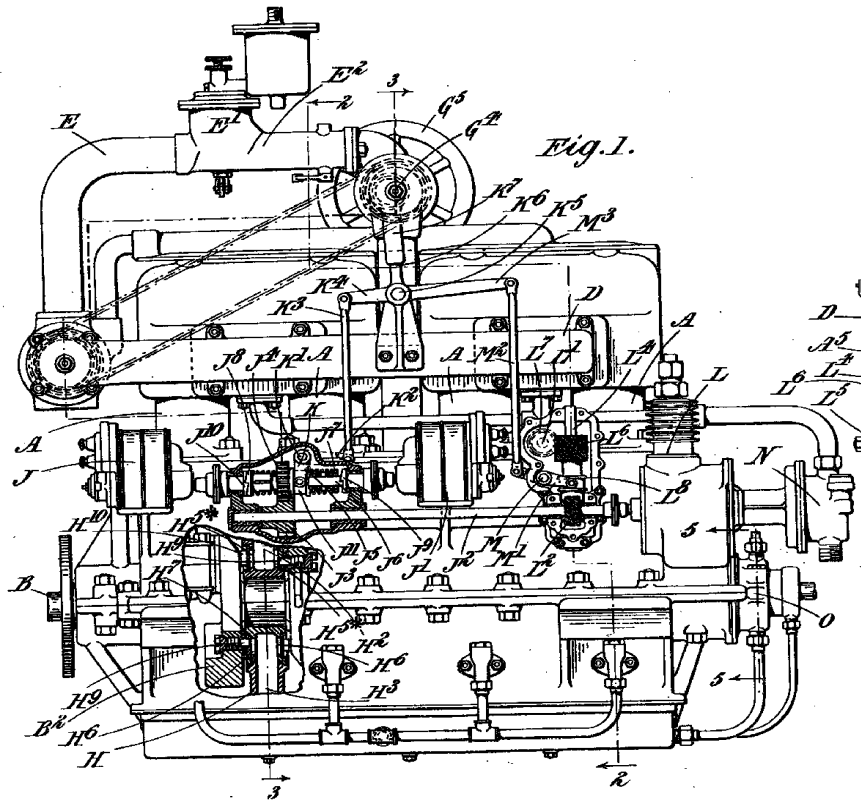
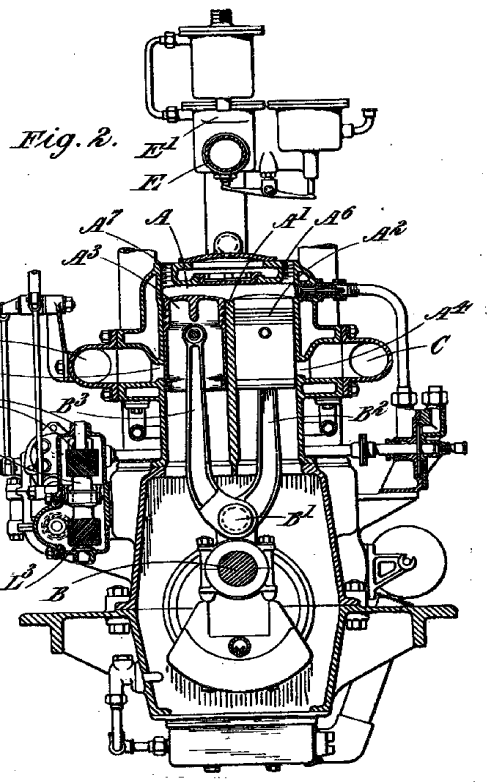
A.D. 1915. Feb. 12. № 2305.
LAMPLOUGH'S Complete Specification.

(2 SHEETS)
SHEET 1.

[This Drawing is a reproduction of the Original on a reduced scale]





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[This Drawing is a reproduction of the Original on a reduced scale.]

Fig. 1.

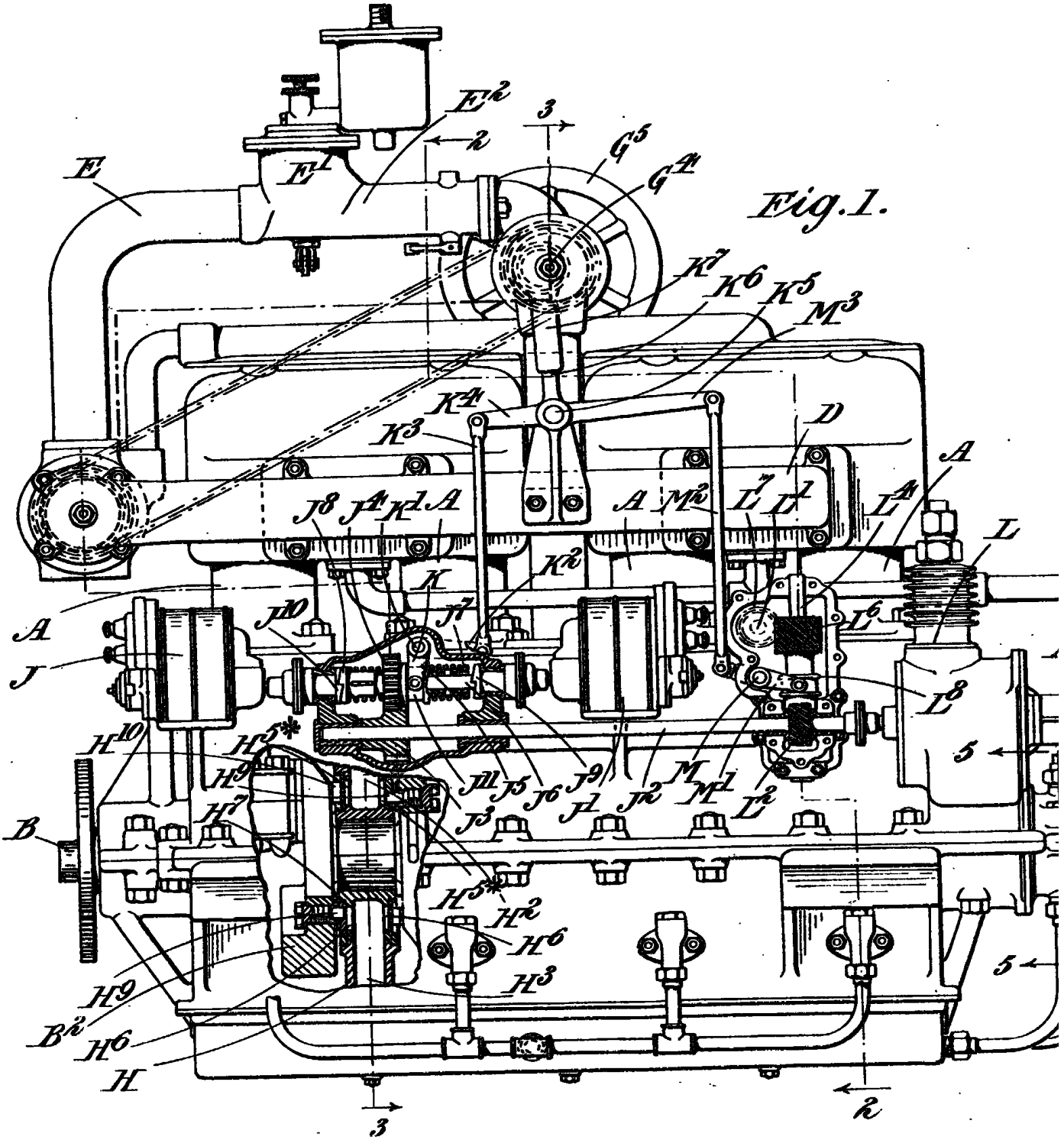

Fig. 2.

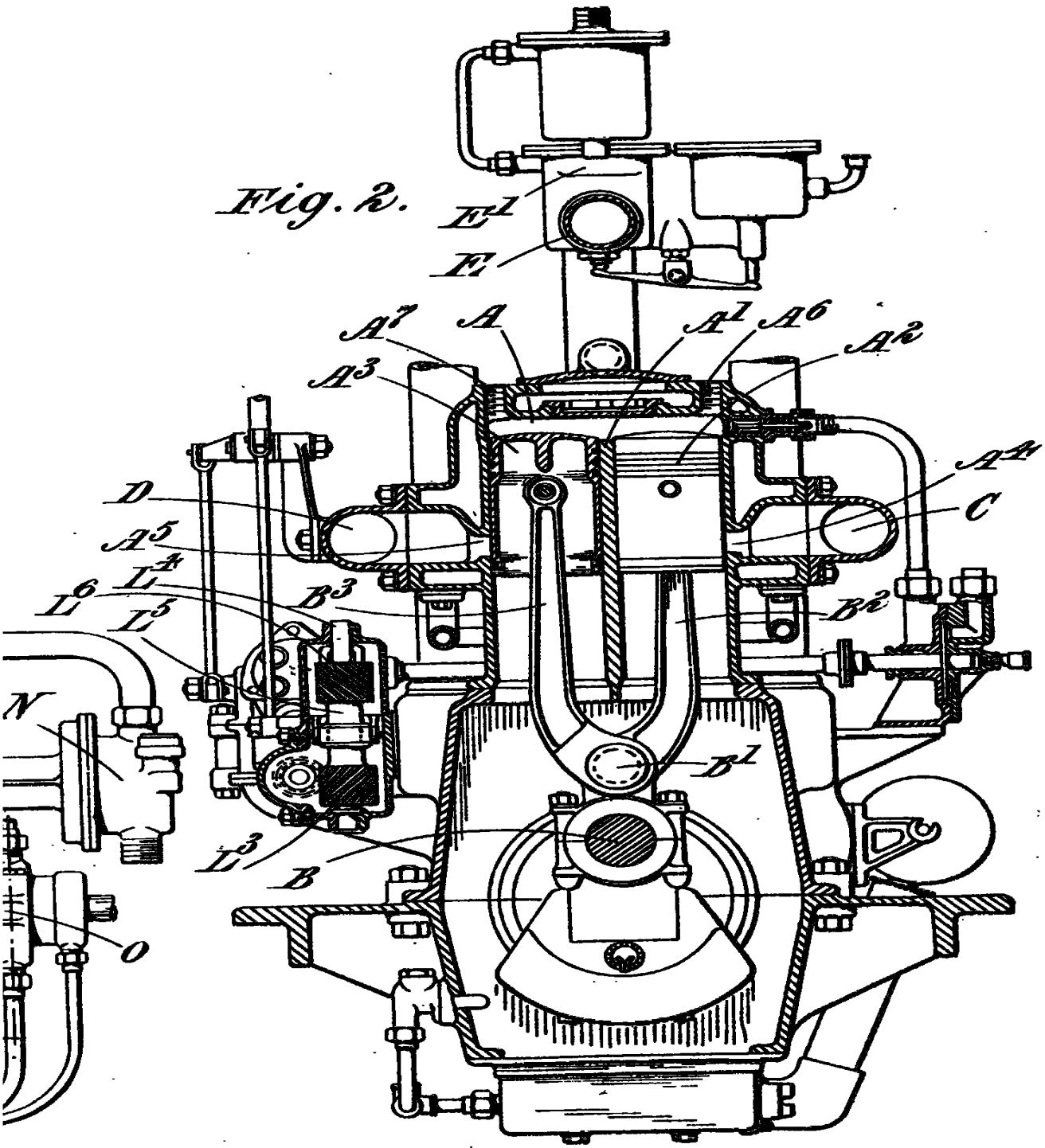

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Fig. 3.

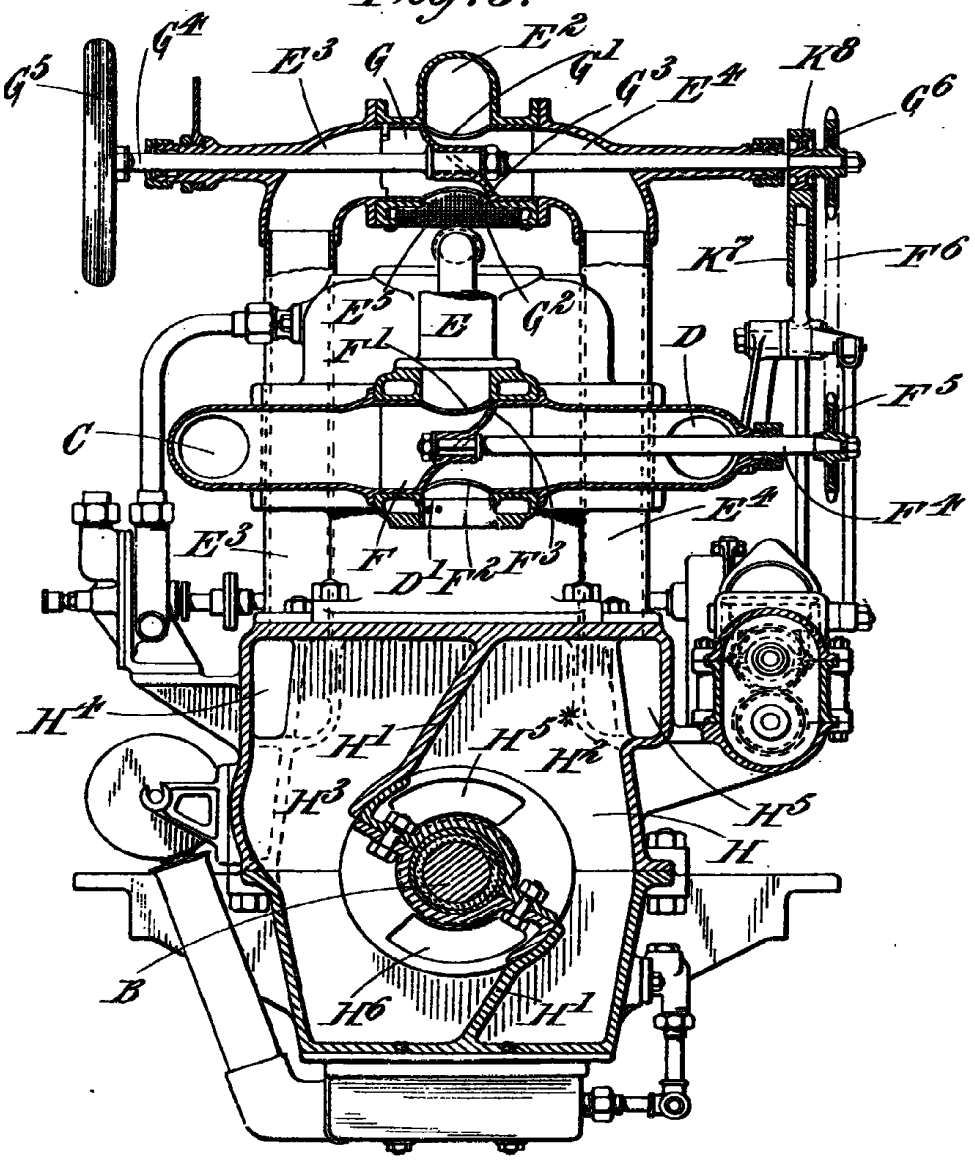


Fig. 4.

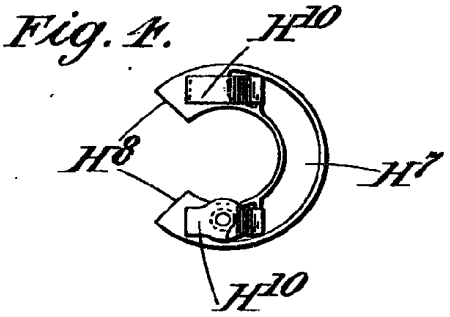
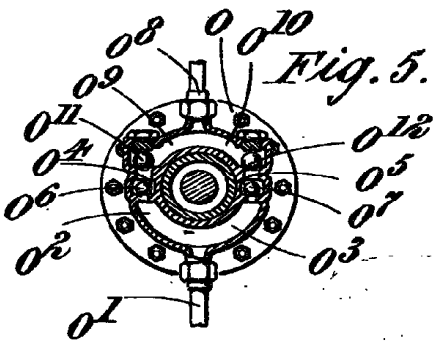


Fig. 5.



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