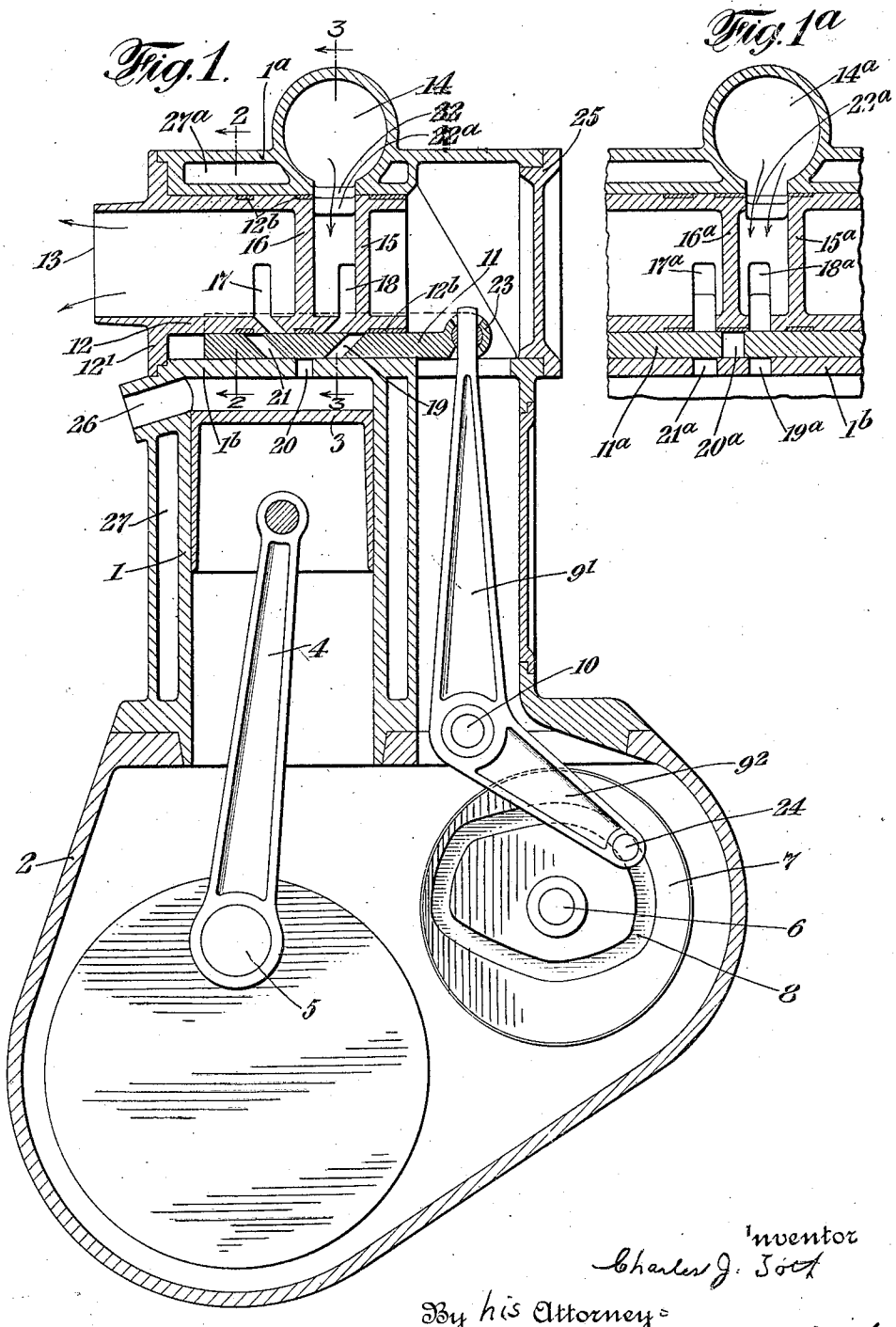
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ENGINE

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Fig. 3.

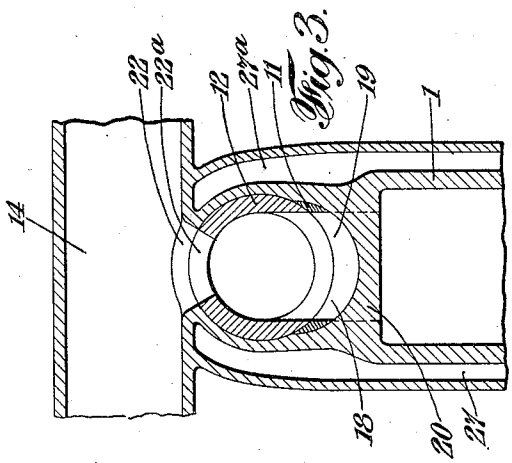


Fig. 2.

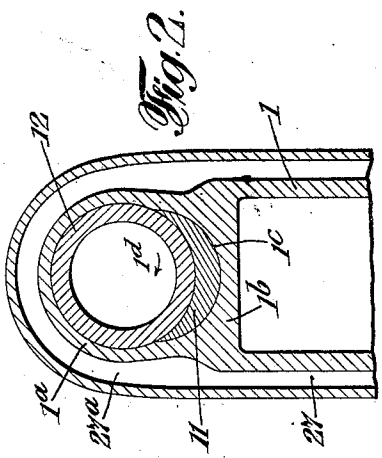
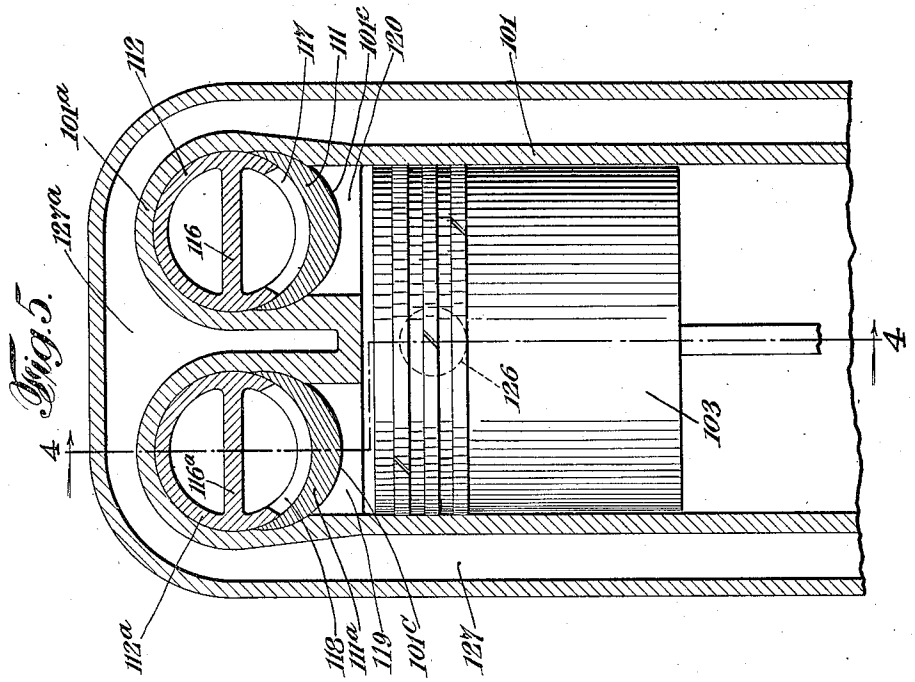


Fig. 5.



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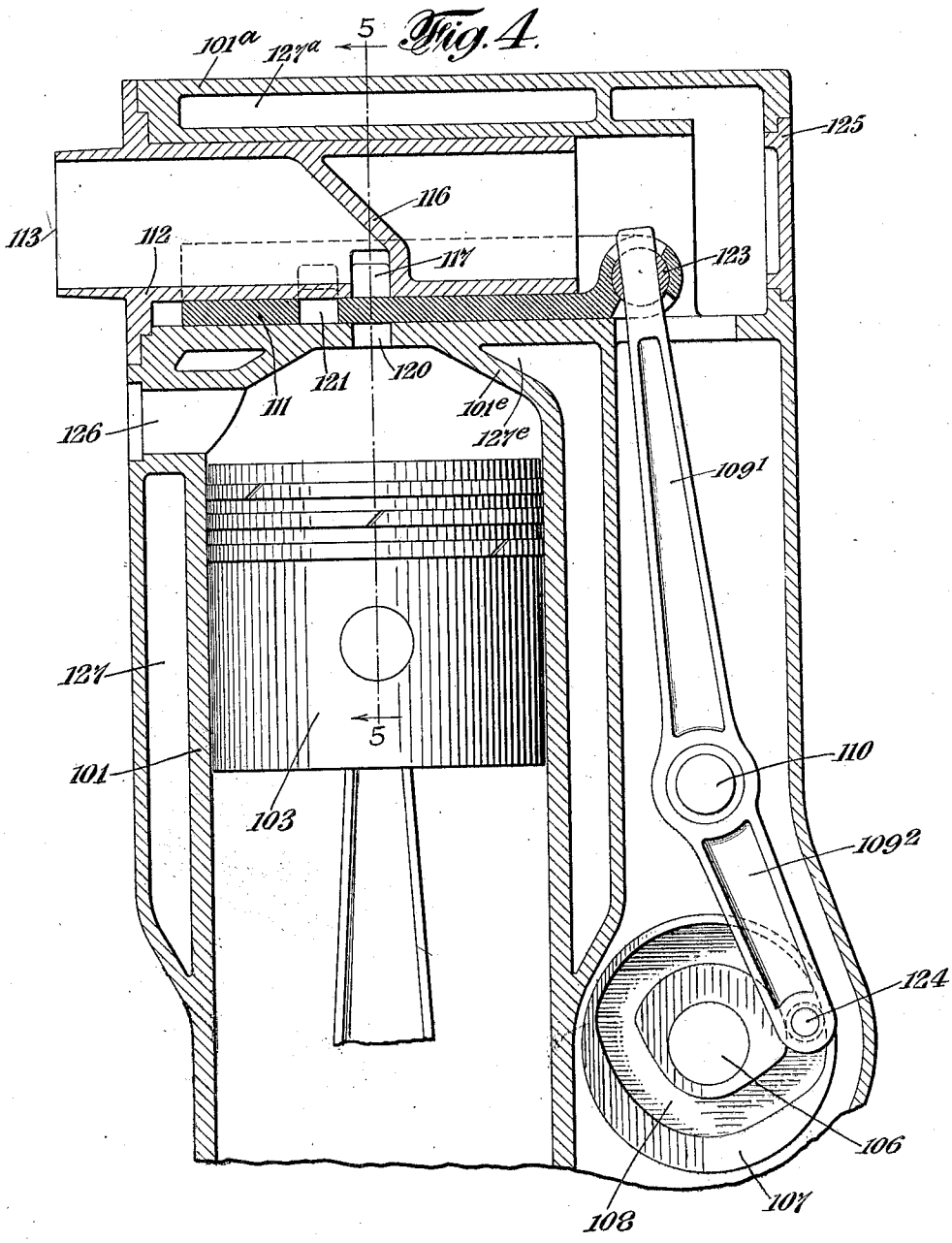
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Fig. 4.



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Fig. 7.

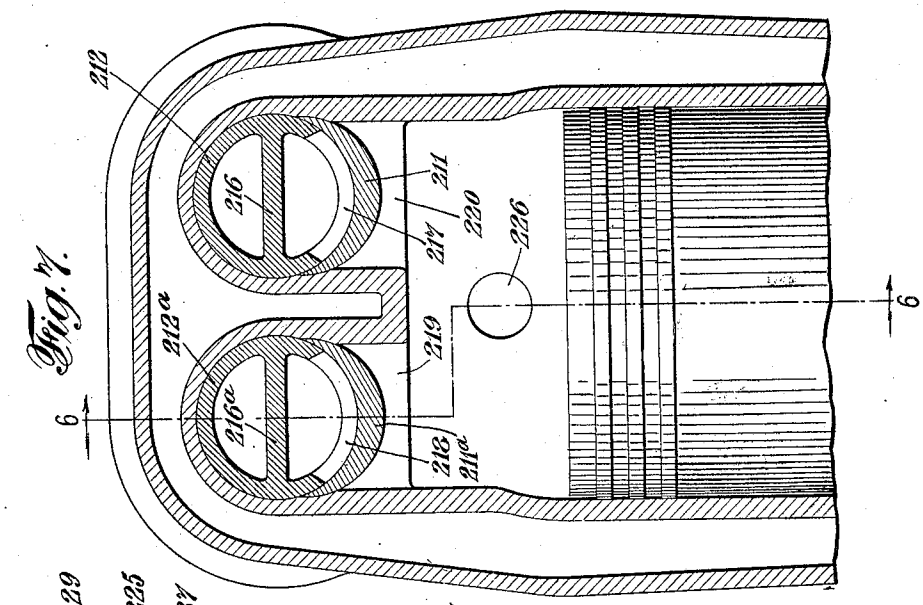
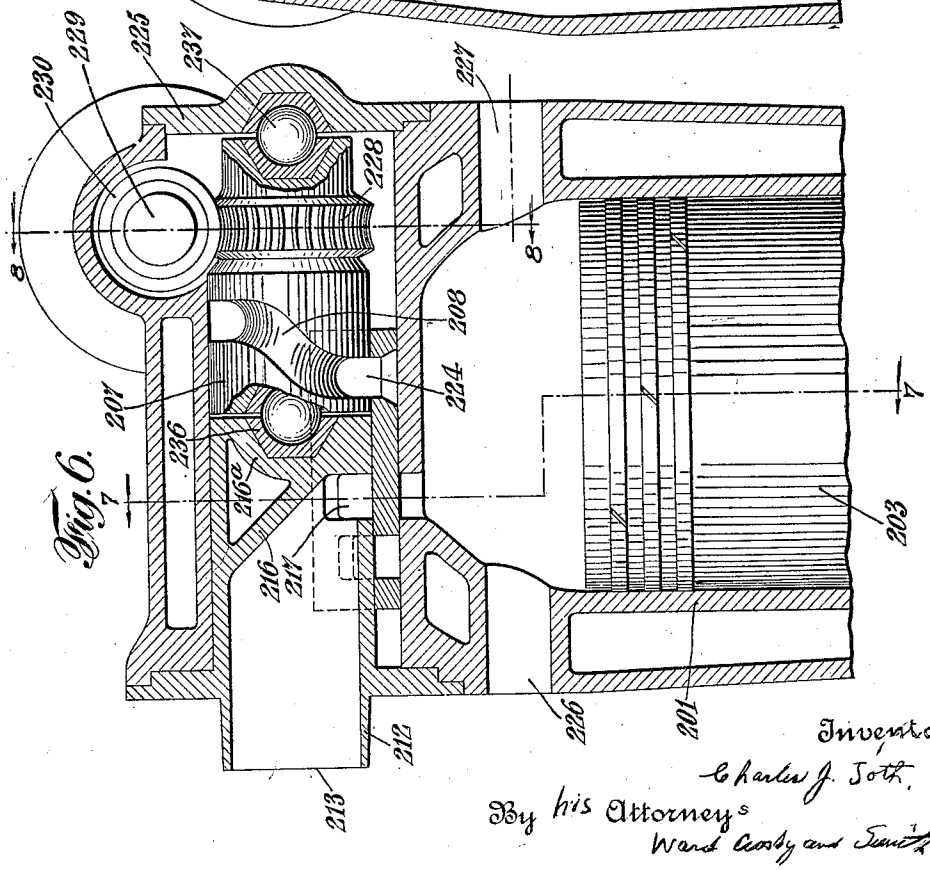


Fig. 6.



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Fig. 9.

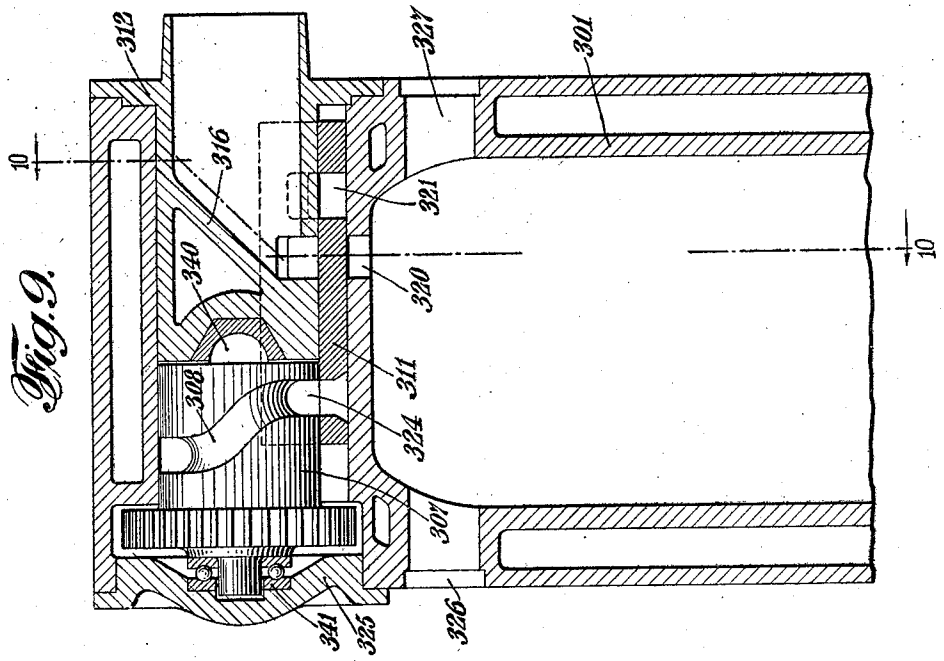
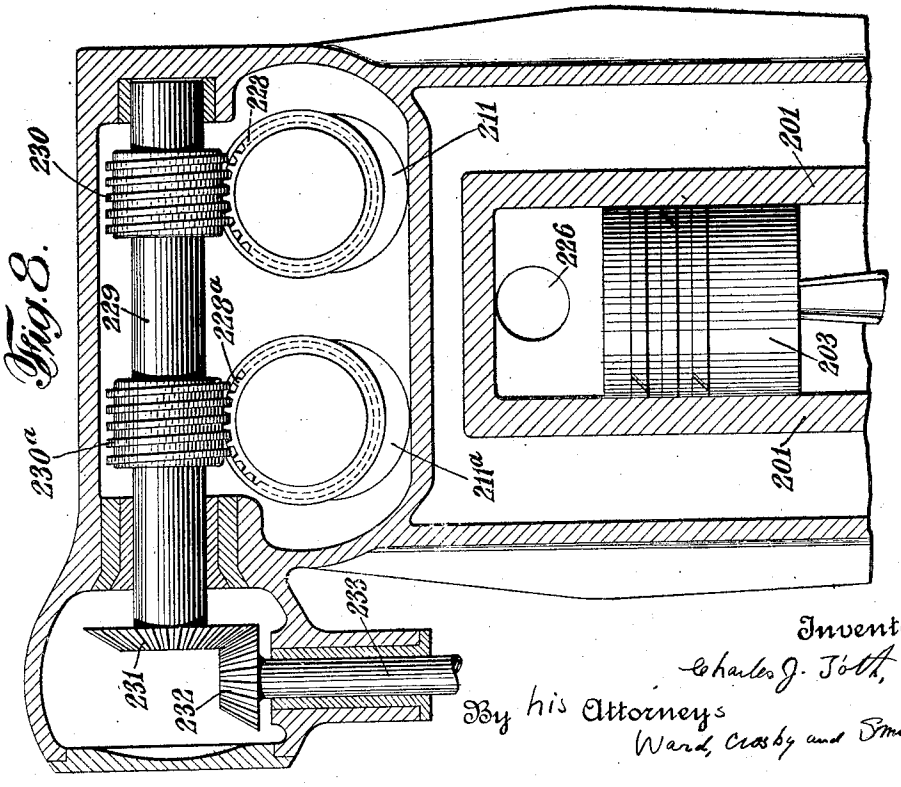


Fig. 8.



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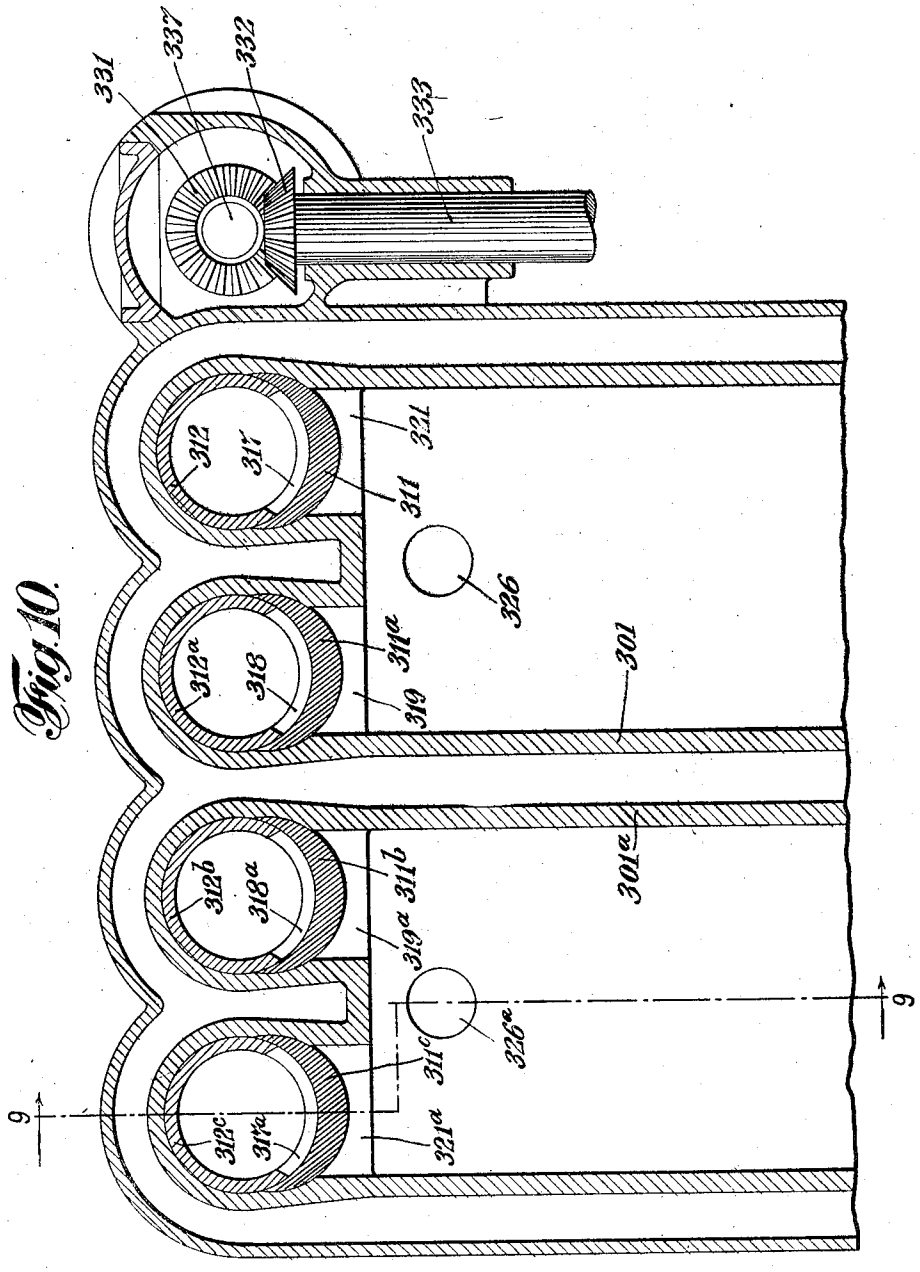


Fig. 10.

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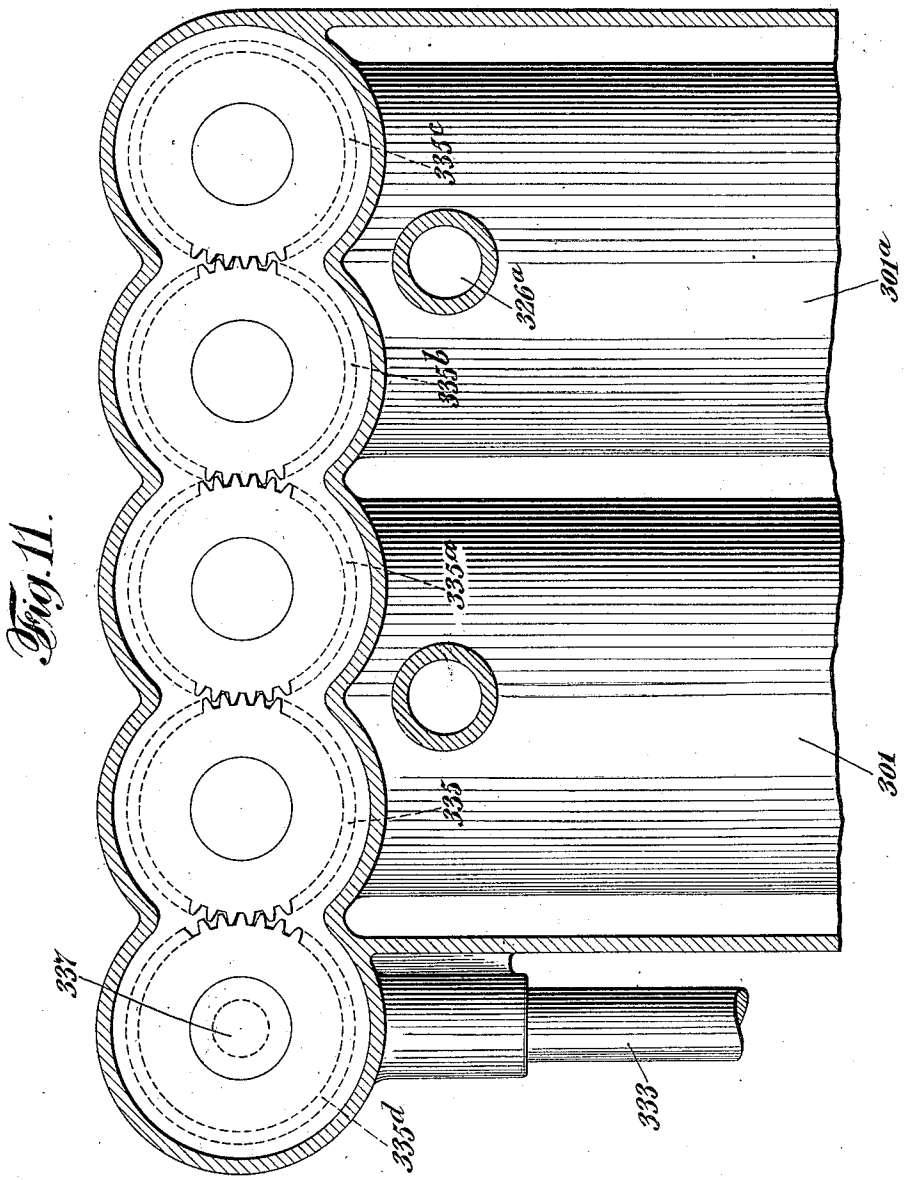


Fig. 11.

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Fig. 13.

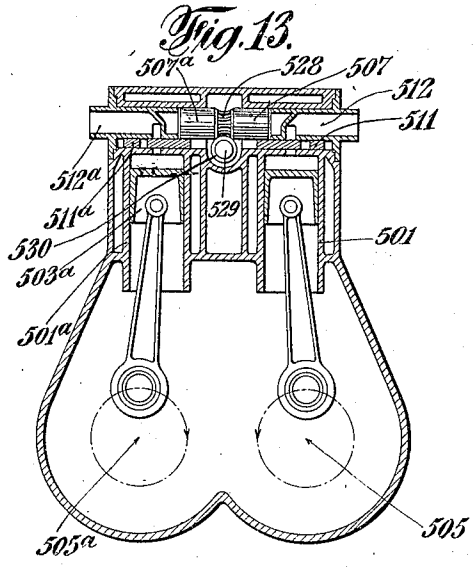


Fig. 12.

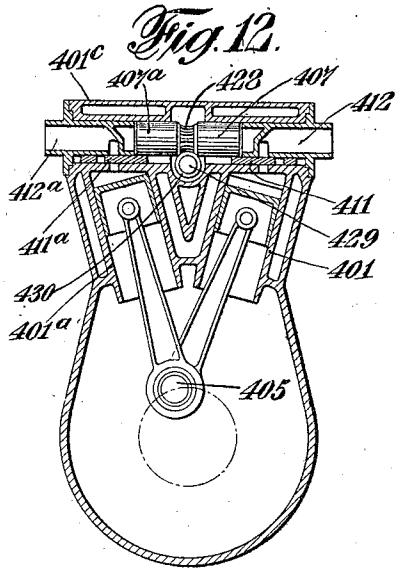
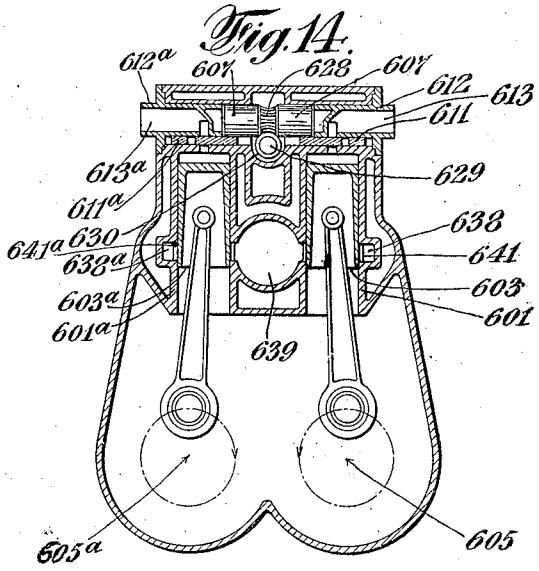


Fig. 14.



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UNITED STATES PATENT OFFICE.

CHARLES J. TÓTH, OF STAPLETON, NEW YORK, ASSIGNOR TO INTERNATIONAL PROCESS AND ENGINEERING CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

ENGINE.

Application filed May 24, 1922. Serial No. 563,366.

To all whom it may concern:

Be it known that I, CHARLES J. TÓTH, a citizen of the Republic of Uruguay, and resident of Stapleton, New York city, county of Richmond, and State of New York, have invented certain new and useful Improvements in Engines, of which the following is a specification.

The invention relates to improvements in engines and particularly to internal combustion engines of both the four cycle and the two cycle type. More particularly, the invention relates to improvements in valves and valve mechanisms, the same being particularly adapted for use in connection with internal combustion engines, and combinations of such valves and valve mechanisms with other elements of the engine.

In accordance with the invention valves of sliding type are mounted on the outside of the engine cylinders. Preferably the slide valve takes the form of what may be termed a partial sleeve, slidably mounted between an exterior surface of the cylinder and another member which serves as a guiding means for the valve and also as a conduit for the inlet or exhaust gases. Preferably, also, the slide valve is mounted on the end wall or closure of the working cylinder, the invention not, however, being necessarily limited to such location.

With such a construction, as applied to internal combustion engines, an opening or openings will be provided in a wall of the engine cylinder which opening or openings will be controlled by one or more slide valves on the outside of the cylinder, which valve or valves will be moved intermittently in such manner as to control the admission of fresh charge to and exhaust of burnt gases from the engine cylinder at appropriate times.

Various advantages accrue from the location of such valves in positions where they are separated from the combustion chamber of the engine. A slide valve on the outside of the cylinder will have only a portion of the same exposed to the heat of the exploded charge in the cylinder, namely the portion of the valve which may be exposed momentarily to such heat through the opening or openings in the cylinder wall outside of which the valve moves. Furthermore valves positioned in the manner contemplated by the present invention may be of comparatively short length in comparison, for example, with sleeve valves positioned within an engine cylinder surrounding the piston which valves are necessarily at least as long as the working cylinder itself. By thus decreasing the length of the valve, reduction in weight and reduction in friction during operation are effected.

The location of such valves on the outside of the cylinder has a further advantage in that the transfer of heat from the engine cylinder to the cooling means therefor will be less interfered with than in constructions in which the valve is located inside the cylinder. This advantage is particularly marked when the valve is located on the end closure or head of the cylinder.

Another advantage resulting from the location, arrangement and method of operation of valves, as contemplated by this invention, is that the outside dimensions of the engine and weight of the stationary and moving parts may be considerably reduced; this by comparison, for example, with engines having internal sleeve valves, in which the dimensions of the parts must be greater for reasons subsequently to be explained.

Objects of the invention comprise the provision of improved valves and valve constructions of the character referred to. A further object is the provision of exceedingly simple and effective actuating mechanisms for such valves. Another object is the provision of a construction in which the valve mechanism is silent and smooth in operation and in which the parts pertaining to the valve mechanism may be examined, removed and interchanged very simply and without necessitating the dismantling of the engine cylinder. Another object is the provision of a construction in which the various castings or members comprising the cylinder and valve construction may be of simple and substantial design and proportion. Other objects and advantages of

the invention will be pointed out hereinafter.

The invention consists in the novel construction, arrangement and combination of parts hereinafter described according to the preferred embodiments thereof. The invention will be more particularly pointed out in the appended claims.

In order that the invention may be more clearly understood attention is hereby directed to the accompanying drawings illustrating certain forms of apparatus embodying the invention. In the drawings—

Fig. 1 represents a vertical section through an engine cylinder, valve mechanism and valve actuating mechanism, in which a single partial sleeve valve is provided for each cylinder to control both the inlet and exhaust operations thereof;

Fig. 1ª is a partial vertical section through the cylinder head construction of an engine similar to that shown in Fig. 1, illustrating a modification thereof;

Figs. 2 and 3 are respectively vertical sections taken on line 2—2 and line 3—3 of Fig. 1;

Fig. 4 is a vertical section through an engine cylinder, valve and valve operating mechanism showing a modified form of construction in which separate sleeve valves are provided for controlling the exhaust and inlet of each cylinder, this section being taken on line 4—4 of Fig. 5;

Fig. 5 is a vertical section taken on line 5—5 of Fig. 4;

Fig. 6 is a vertical section through the upper portion of the cylinder and valve construction of an engine having a modified form of valve actuating mechanism.

Figs. 7 and 8 are vertical sections taken respectively on lines 7—7 and 8—8 of Fig. 6;

Fig. 9 is a view similar to that shown in Fig. 6 illustrating a further modification in the valve actuating devices;

Figs. 10 and 11 are sections taken respectively on lines 10—10 and 11—11 of Fig. 9;

Fig. 12 is a vertical section taken through an engine having a pair of cylinders arranged in V formation with the valve mechanism therefor;

Fig. 13 is a similar view in which the cylinders are arranged in parallel relation, and

Fig. 14 is a view similar to that shown in Fig. 13 but illustrating a form of construction which may be used in the case of two cycle engines, the constructions specifically illustrated in Figs. 1 to 12, being designed for use as four cycles engines.

Referring first to Figs. 1, 2 and 3 of the drawings, a four cycle type of internal combustion engine is illustrated having an engine cylinder casting 1. The head casting 1ª may be cast in one piece with the cylinder casting 1, or may be separated therefrom and attached thereto.

The cylinder is shown as mounted in the usual manner on the crank case 2 within which crank shaft 5 and a cam shaft 6 are rotatably mounted. The working piston 3 within the cylinder is connected by connecting rod 4 to the crank of crank shaft 5 in the usual manner.

The slide valve 11 is positioned outside of a wall of the cylinder, preferably outside the end closure or wall 1ᵇ of the cylinder. The head casting 1ª is provided with a cylindrical bore extending at right angles to the axis of the cylinder. A member 12 of tubular form, referred to herein as a conduit member, is inserted within the bore of head 1ª, member 12 having a flange 12¹ at one end which bears against the adjacent end of the cylinder head construction.

Member 12 is so mounted as to leave a space between the lower surface of the same and the surface of the upper wall or closure 1ᵇ of the combustion chamber. Preferably this upper wall is formed with a recess or trough in its upper face which is preferably of semi-cylindrical form with its axis extending parallel to and below the axis of tubular member 12. The cross section of this curved surface is indicated by the line 1ᵉ in Fig. 2, this line being approximately a semicircle described about the point 1ᵈ as a center.

The valve member 11 is slidably mounted between surface 1ᵉ of the cylinder casting and the lower outside surface of tubular member 12. The valve is accordingly a partial sleeve, and is of crescent shape in cross section in the form of construction particularly illustrated. The cylinder head construction 1ª extends upwardly from the top wall 1ᵇ of the cylinder (Fig. 2) and accordingly the semi-cylindrical seat 1ᵉ in which the valve rests may be described as formed chiefly in the upward extension 1ª of the end closure 1ᵇ of the combustion chamber.

The upper surface of valve 11 may readily be formed with the same diameter as the bore of casing 1ª, that is the same as the outside diameter of tubular member 12. The lower cylindrical surface of member 12 serves to hold the valve in position so that it will move back and forth with a straight line motion.

The valve is reciprocated in the construction shown in Fig. 1 by means of a rocker arm 9¹, 9², more fully to be described hereinafter.

Conduit member 12 in the form of construction being described has a pair of openings 17 and 18 extending through the lower portion of its cylindrical wall and an opening 22ª extending through the upper

portion of its cylindrical wall. A pair of division walls 15 and 16 extend across the interior of member 12, partition 16 extending between openings 17 and 18 and partition 15 on the opposite side of member 18. Opening 17 is the exhaust opening of member 12 and opens into an interior portion of the member which is open at end 13 thereof. The usual exhaust piping may be secured to member 12 at end 13.

Opening 18 of member 12 is an inlet opening and communicates through the space between walls 15 and 16 with the upper opening 22^a. The latter opening is in alignment with opening 22 in the upper portion of the cylinder head member 1^a, opening 22 leading into the inlet piping 14, which is shown as mounted on the upper portion of cylinder head 1^a and extending at right angles to the axis thereof.

A pair of openings 19 and 21 are provided in valve 11 while the upper wall 1^b of the combustion chamber has a single opening 20 formed therethrough, preferably in a position intermediate openings 17 and 18 of member 12. Openings 17, 18, 19, 20, and 21 are all preferably the same in cross sectional area. Accordingly, communication with the combustion chamber will be established through openings 18, 19 and 20 when opening 19 of the valve aligns with openings 18 and 20 and communication with the exhaust passage of member 12 will be established through openings 20, 21, and 17 when opening 21 of the valve aligns with openings 17 and 20.

In a four cycle engine, as described, valve 11 will occupy the position shown in Fig. 1 at the moment of ignition of the intaken charge and during the expansion or working stroke of the engine. In this position the combustion chamber is cut off from communication with both the inlet and exhaust passages 18 and 17 of member 12. After the working stroke has been accomplished the valve will be so moved as to align opening 21 thereof with openings 20 and 17 so as to provide a direct passage for the expulsion of the burnt gases from the interior of the cylinder. After the exhaust stroke has been completed the valve will be moved in the opposite direction sufficiently to cause opening 19 to align with openings 20 and 18. Piston 3 will now be moving inwardly on its admission stroke and will provide a suction so that the fresh charge will be admitted to the cylinder from inlet piping 14. At the end of the admission stroke valve 11 will again move into its central position shown in Fig. 1 cutting off the interior of the cylinder from both passages 17 and 18. The compression of the intaken charge will now be accomplished in the usual manner.

The engine as described will operate upon either the usual mixture of gas and air, the charge being fired by the usual spark plug, or upon an intaken charge of fresh air, liquid fuel being injected into the combustion chamber when the air has been sufficiently compressed therein. An opening is indicated in the cylinder casting at 26 in which a spark plug or fuel injector may be mounted as the case may be.

The intermittent movement of valve 11 described is accomplished in the construction referred to by means of rocker arm 9^1, 9^2, pivoted on a pin 10. The lengths of arms 9^1 and 9^2 of the rocker arm will, of course, be given a desired ratio in proportion to each other to effect the desired movement. The upper end of arm 9^1 is connected to valve 11, preferably by means of a pin 23 rotatably mounted in a suitable bearing at the end of the valve. The other arm 9^2 of the rocker carries a pin 24 which fits in a cam groove 8, provided on a disc 7 affixed to, or made integral with, the shaft 6. This shaft preferably rotates at one half the speed of crank shaft 5 and may be rotated therefrom, or in any desired manner which it is not deemed necessary to illustrate. Cam groove 8 will be given the proper configuration to provide the intermittent movement required for valve 11.

An alternative construction is shown in Fig. 1^a in which valve 11^a has a single opening 20^a therein in place of the two openings 19 and 21 in the form first described. Correspondingly the upper wall 1^b of the combustion chamber is provided with a pair of openings 19^a and 21^a in place of the single opening 20 shown in Fig. 1. Member 12^a is provided with a pair of openings 17^a and 18^a similar to openings 17 and 18 in Fig. 1. In this case the movement of the slide valve may be the same as that in the case previously described, opening 20^a of the valve aligning either with openings 19^a and 18^a or with openings 21^a and 17^a or occupying an intermediate position out of connection with any of said openings.

In the constructions described the conduit member 12 or 12^a is rigidly mounted in position within the bore of the cylinder head member. Suitable packing or piston rings, such as are indicated at 12^b, may be provided between outer surfaces of member 12 and the cylinder head member and the valve member, as shown, to prevent escape of gas. For the same reason the joint between flange 12^1 of member 12 and the cylinder casting and cylinder head is preferably made with several offset steps, as shown.

The cylinder may be provided with suitably cooling means such as the jacket 27, while the cylinder head is shown as provided with a jacket 27^a. As is indicated in Figs. 2 and 3, jacket 27^a may constitute a continuation of jacket 27.

A similar construction is shown in Figs.

4 and 5 of the drawings with the difference, however, that a pair of slide valves are used, one controlling the inlet and the other controlling the exhaust from the cylinder in place of the single valve controlling both operations in the form of the invention previously described. As indicated, the cylinder 101 has a cylinder head construction 101^a through which extend a pair of transverse bores. A pair of conduit members 112 and 112^a are mounted in these bores in the same manner as previously described in connection with the conduit member 12 in the construction illustrated in Fig. 1. These transverse bores and the tubular conduit members mounted therein are preferably positioned side by side as shown in Fig. 5.

The top closure for the cylinder is provided with a pair of upwardly curved seats beneath conduit members 112 and 112^a. The curvature of these seats in cross section is shown in Fig. 5 at 101^c and 101^c respectively. The slide valves 111 and 111^a are mounted on seats 101^c and 101^c beneath conduit members 112 and 112^a, in the same manner as has been previously described in connection with valve 11.

Valve 111 is adapted to control the exhaust from the cylinder and valve 111^a to control the inlet of fresh charge thereto. The top closure for the cylinder has an opening 120 therethrough which may be placed in communication with the opening 117 in member 112 when valve 111 is moved so as to align opening 121 therein with openings 120 and 117. At such times burnt gases may be expelled from the cylinder through these aligned openings and through the end 113 of member 112 to the exhaust piping.

The top closure of the cylinder is also provided with an opening 119 (Fig. 5) which may be placed in communication with an opening 118 in member 112^a, when valve 111^a is moved so as to align an opening therein with openings 119 and 118. The opening in valve 111^a, just referred to, is not shown, but will be exactly the same as opening 121 in valve 111 shown in Fig. 4. When the three openings are thus aligned fresh charge may enter the combustion chamber through the three aligned openings, this charge coming from the inlet piping, connected to the open end of member 112^a corresponding to the open end 113 of member 112, shown in Fig. 4.

It will be understood that the two partial sleeve valves may be made exactly alike and the two members 112, 112^a, made exactly alike, each of these latter members having a single partition therein, 116, 116^a, the left-hand ends of members 112, 112^a, referring to Fig. 4, connecting with the exhaust and inlet piping.

The mechanism for operating valve 11 may, as shown, comprise rocker 109^1, 109^2, pivoted on pin 110, arm 109^1 being suitably connected at its upper end, as shown at 123, to the valve. The lower end of arm 109^2 carries a pin 124 which operates in a cam slot 108 on disc 107 secured to the half time shaft 106. The inlet controlling valve 111^a will be operated by an entirely similar mechanism which accordingly is not illustrated, it being understood that the connections for operating the two valves are suitably arranged to cause these valves to open and close the cylinder inlet and exhaust ports at the proper times.

It is preferable to have all of the similar parts identical in construction and size, so that the same may readily be made interchangeable. Thus the castings 112, 112^a, the partial sleeve valves 111, 111^a, the rocker arms, cam discs, and pins for operating the rocker arms from the cam grooves.

With this construction both valves will shut off communication between the cylinder and the exhaust and inlet passages during the compression and working strokes of the piston 103. This position of valve 111 is shown in Fig. 4. During the exhaust period of operation valve 111 makes a slight movement to the right and establishes communication between openings 120 and 117. At the end of the exhaust period this valve returns to its position indicated in Fig. 4, and there remains during the three other cycles of the engine. Correspondingly the inlet controlling valve 111^a has a slight travel to the right as the admission stroke of the engine is about to begin to establish communication between the inlet piping and the interior of the cylinder through the cylinder port 119. At the end of the admission stroke this valve returns to its closing position similar to that shown for valve 111 in Fig. 4 and there remains during the compression, working and exhaust strokes of the engine.

With the construction described the partial sleeve valves will have a comparatively short travel between operative and inoperative positions. The water jacket 127 about the cylinder is preferably extended, as shown at 127^a, above and between the portions of the cylinder head casting in which conduit members 112, 112^a, are positioned. The inner wall of the cylinder is also preferably provided with an upwardly arching top closure portion as indicated at 101^e, an annular water jacket space 127^e accordingly being provided above a considerable portion of the top of the working cylinder and beneath a considerable portion of the two valves.

In the construction illustrated the cylinder head may be closed at its right hand end except for an inspection opening closed by a cover 125.

Referring now to the construction shown

in Figs. 6 to 8 of the drawings, the same form of valves as those just described are illustrated, valves 211 and 211ª being shown to control the exhaust and inlet operations of cylinder 201. Conduit members 212 and 212ª are shown as mounted in transverse bores in the cylinder head construction 201ª. Burnt gases exhaust through openings 220, 221 and 217, formed respectively in the top wall of the cylinder, the valve 211, and member 212, when valve 211 is moved to align its opening 221 with openings 220 and 217. Similarly the fresh charge will be taken into the cylinder when valve 211ª is moved to align its opening with openings 219 and 218 in the cylinder and the member 212ª respectively.

The construction illustrated in Figs. 6 to 8 differs from the arrangement shown in Figs. 4 and 5, in the valve controlling mechanism, and in the fact that this arrangement permits the use of partial sleeve valves of reduced size in comparison with those previously described.

In the arrangement under discussion a cylindrical member 207 having a cam groove 208 extending about the periphery thereof takes the place of the cam disc 107 shown in Fig. 4. Member 207 is rotatably mounted within the bore of the cylinder head member 201ª in which the conduit member 212 is mounted, member 207 being in axial alignment with member 212. A pin 224 is carried by sleeve valve 211 and fits within cam groove 208.

The rotation of member 207 causes the reciprocation of valve 211 with a suitable timing to control the exhaust operations of the cylinder. A member similar to member 207 is mounted in alignment with conduit member 212ª, valve 211ª being provided with a pin similar to pin 224 fitting in a cam groove similar to groove 208, the rotation of the member carrying the cam groove referred to controlling the inlet operations of the cylinder.

Member 207 is preferably held in position by a simple bearing means preventing longitudinal movement thereof. In the arrangement indicated in Fig. 6 a single ball bearing 236 is used at the left hand end of member 207 and another single ball bearing 237 at the right hand end of the member. Conduit member 212 is provided with a suitable seat 216ª for ball bearing 236 while the seat for ball bearing 237 may be provided by a disc 225 mounted in position to close the right hand end of the cylinder head construction. The arrangement for the member corresponding to 207 which controls the operation of the inlet valve 211ª is similar to that just described and accordingly is not illustrated.

The cam groove 208 is so arranged that valve 211 will have a suitable intermittent reciprocating movement, this also being true of the controlling means for valve 211ª. The arrangement may be such that each of the valves will remain stationary in the position indicated in Fig. 6 during three of the four cycles of the engine. Thus the inlet controlling sleeve 211ª will remain stationary during the working, exhaust, and compression cycles and will move into position to permit admission of charge only during the admission cycle of the engine. Similarly the exhaust controlling sleeve 211 remains stationary during the inlet, compression, and working cycles and moves only during the exhaust cycle to a position in which it establishes direct communication by its opening 221 between the cylinder opening 220 and opening 217 in member 212.

The rotation of the cam-slot-bearing members may be obtained, as is indicated in Fig. 8, by means of a vertical shaft 233 which may be suitably geared at its lower end to the engine crank shaft. At its upper end it is connected by gear 232 to gear 231 on a horizontal shaft 229 which is mounted in suitable bearings in the upper portion of the cylinder head construction 201ª.

Shaft 229 rotates member 207 by a suitable connection such as the worm 230 on shaft 229 meshing with a worm wheel 228 on member 207. Similarly shaft 229 is connected to rotate the other member corresponding to member 207 by which the inlet valve is moved. As shown shaft 229 may be provided with a second worm, 230ª, which meshes with a worm wheel 228ª on the member corresponding to member 207, which controls the operation of valve 211ª, as stated. The gear ratios and conformation of the cam grooves described may, of course, readily be arranged to produce the desired results.

In Figs. 9 to 11 a similar construction is shown in which, however, a different arrangement is illustrated for controlling the rotation of the cylindrical members 307, carrying cam grooves 308 and corresponding to members 207 in the form of construction just described.

In the construction here illustrated each of the cam-groove-cylinders 307 carries a spur gear, these gears being indicated in Fig. 11 at 335, 335ª, 335ᵇ, and 335ᶜ, all of these gears meshing together.

In the construction illustrated a pair of engine cylinders 301 and 301ª are indicated. Cylinder 301 (Fig. 10) is provided with a pair of valves, 311 governing the exhaust and 311ª governing the admission, while cylinder 301ª is provided with a valve 311ᶜ controlling the exhaust, and a valve 311ᵇ controlling the admission. These valves are similar to the valves previously described, and are mounted in the same manner, as has been previously described. Each valve is

provided with a pin 324 fitting into the cam groove 308 of the cylindrical member 307 which controls the operation of that valve.

In the arrangement shown a separate gear 335[d] (Fig. 11) is mounted on a short transverse shaft 337 which may be rotated from the engine crank shaft by means of vertical shaft 333 which drives shaft 337 through beveled gears 332 and 331 (Fig. 10). Gear 335[d] meshes with gear 335 and accordingly causes the rotation of all the gears 335, 335[a], 335[b] and 335[c]. The timing and arrangement of the parts will be such as to cause the operation of the valves in the desired manner.

Cylindrical member 307 may be held against longitudinal movement by bearing means such as the ball bearings 340 and 341 illustrated. The arrangement of the openings through the cylinders, valves and conduit members 312, 312[a], 312[b] and 312[c] will be understood from the description of the corresponding parts given in the constructions previously described.

In Fig. 12 an adaptation of the valve control mechanism above described for multi-cylinder engines is indicated. In this figure an engine is shown having a crank shaft 405 and a pair of cylinders 401 and 401[a] mounted in V formation above the same. One piston in each cylinder is connected by suitable connecting rod with the same throw of the crank shaft.

In the arrangement illustrated each cylinder is intended to have a pair of partial sleeve valves, one controlling the inlet and the other the exhaust for the cylinder. These valves may be the same as those previously described in connection, for example, with Figs. 6, 7 and 8, one valve for one cylinder being shown at 411 and the corresponding valve for the other cylinder at 411[a]. A cylinder head structure 401[c] is provided, this being common to both cylinders. Rotary cylindrical cam groove members may be used for reciprocating the valves intermittently, a pair of such members being indicated at 407 and 407[a] to control the valves 411 and 411[a] in the manner previously described. Controlling members 407 and 407[a] may be and preferably are formed as one integral construction, the two portions of which 407 and 407[a] will control the exhaust valves of the two cylinders while a similar member (not shown) containing portions similar to portions 407 and 407[a] will similarly control the two inlet valves.

A single shaft 429 is indicated as extending transversely through the lower portion of the cylinder head construction in a position intermediate the upper ends of the two cylinders. This shaft may be rotated at a suitable speed in any desired way and will serve to drive the rotary cam groove members. As illustrated a cam 430 on shaft 429 may engage a worm wheel 428 mounted on the controlling member 407, 407[a]. A similar worm drive may serve to rotate the other cam groove member from shaft 429. The connections may be the same as those indicated in Fig. 8 for driving the cylindrical member 207 and its companion cylindrical member and accordingly further illustration is thought unnecessary.

The construction shown in Fig. 13 is similar except that the two cylinders 501 and 501[a] are shown mounted in parallel relation above a pair of crank shafts 505 and 505[a]. Crank pins of the crank shafts are connected to pistons 503 and 503[a] in the two cylinders. The construction is otherwise the same as that shown in Fig. 12, a single shaft 529 being used to rotate the cylindrical cam groove members, one of which 507 and 507[a] is illustrated as controlling the exhaust slide valves 511 and 511[a] of the two cylinders. The other details of the construction may be the same as have previously been described.

A further modification is illustrated in Fig. 14, in which an adaptation of the construction previously described for two cycle internal combustion motors is indicated. A pair of cylinders, 601, 601[a], are illustrated as mounted above a pair of crank shafts 605, 605[a]. The two pistons 603, 603[a], one in each cylinder are connected by the usual connecting rods to crank pins on the two crank shafts.

Each cylinder is illustrated as having a port extending through its top closure, these ports being controlled by slide valves 611, 611[a], similar to those previously described. The valves may be reciprocated intermittently by the cam groove arrangement previously described, a cylindrical cam groove member having portions 607, 607[a], being indicated as rotated by the worm drive from shaft 629 in the manner previously described.

In a two cycle engine it is highly desirable for a so-called means for supercharging the cylinders to be provided. What I term "supercharging" the cylinders may be accomplished by so arranging the structure that the exhaust passages of the cylinders will open before the admission passages open and the exhaust passages will close before the admission passages close. With such an arrangement fresh charge will continue to enter the combustion chambers of the cylinders during the period after the closure of the exhaust ports and before the closing of the inlet ports, this constituting the so-called supercharge of the cylinders.

In the construction illustrated in Fig. 14 such an arrangement is effected by utilizing the working pistons themselves to open and close the exhaust ports, while the inlet ports in the cylinder heads are controlled by the valve arrangement described.

It will be accordingly noted that the admission of fresh charge for the cylinders is drawn in to the combustion chambers during the inward admission strokes of the pistons through the open ends 613, 613ª, of the conduit members 612, 612ª, which may be similar to members 312, 312ª, for example, described in connection with Fig. 9, ends 613, 613ª, of these conduit members being connected to the inlet piping. The cam groove and pin arrangement, the same as has previously been described, will cause valve 611, 611ª, to remain stationary in inoperative position during the compression and working strokes or periods of the engine operation. The valves will move only at the times when admission of fresh charge into the cylinders is to be effected to align the openings through the valves with the openings in the end walls of the cylinders and the corresponding openings in members 612, 612ª. The valves may be caused to move into inlet opening position during a portion of the exhaust period of each cylinder when the incoming charge of fresh mixture or air will aid in scavenging the burnt gases from the cylinders, the inlet connections remaining open, as stated, after the closing of the exhaust ports so that the so-called supercharge of the engine cylinders may be effected during this time.

In the construction shown in Fig. 14 an exhaust outlet passage 639 is shown between the two cylinders, the interior of connection 639 connecting by suitable openings in the opposite walls thereof with passages 638, 638ª, extending around the cylinder walls. The inner walls of the cylinders will have ports 641, 641ª, therethrough adapted to connect the interiors of the cylinders with annular passages 638, 638ª. These passages will be closed by the cylindrical walls of the pistons at all times, except when the working faces of the pistons descend below the same. At this time, the working stroke of the piston having been completed, the burnt gases will escape into passage 639, the arrangement being such that the exhaust ports in each cylinder will be thus opened before the corresponding inlet port is opened by the sliding valve provided for the cylinder and will be again closed before the inlet opening for the cylinder is closed by the sliding valve.

It should be noted that while I have particularly described the arrangement of inlet controlling valves for two cycle engines in connection with an engine having two crank shafts and two groups of cylinders, the invention is not limited to such construction.

The fresh charge may be precompressed in any desired manner before its admission to the combustion chamber, as is highly desirable in two cycle engines. It has not been thought necessary to illustrate any form of precompression means herein, it being noted that where required or desired a suitable arrangement of precompression means may be applied to the construction without interfering with the valve arrangement herein described. It may also be noted that the various necessary engine fittings which are required such as spark plugs, or fuel injection devices, as the case may be, will be used. Openings for the reception of a spark plug or fuel ejector are indicated in Fig. 1 of the drawings at 26, in Fig. 4 at 126, in Fig. 6 at 226, and 227, and in Fig. 9 at 326 and 327.

It will be evident that the various types of construction which have been described all provide slide valves of what may be termed "partial sleeve" type, the construction affording numerous advantages, briefly referred to above. Thus it will be evident that the construction permits the use of valves of this character which are comparatively short, the same being considerably shorter than sleeve valves which have heretofore been positioned between the bore of the cylinder and the piston therein. Accordingly the weight of the parts and the friction of the same in operation will be reduced. This statement applies to all of the forms of construction described, the forms illustrated in Figs. 6 to 14, however, having the advantage over forms shown in Figs. 1 to 5 in that the first mentioned forms do not require as great length of valve as the forms shown in Figs. 1 to 5.

It will also be noted that the location of valves of the character described away from and the outside of the combustion chamber of the engine provides various advantages in comparison with the use of sleeve or other sliding valves within the cylinder. Thus in the present instance the transfer of heat from the interior of the cylinder to the water jackets or other cooling means is interfered with, by the valve construction, as little as possible. This is particularly true where the valve construction is arranged in the head, or on the outer side of the end closure of the cylinder. In this case the cylindrical surface of the cylinder may be very effectively jacketed or provided with other cooling means while the head of the cylinder itself and the valve construction may be jacketed to a considerable extent.

It will also be noted that this arrangement provides for the operation of the engine piston, connecting rod, and valve members with a minimum of clearance or space required for the operation of the same. In constructions such as have been described the cylinder need not be so great in outside diameter or so long as a cylinder having a sleeve valve inside the same to develop the same power. Likewise less space is required for the operation of the crank

shaft, in constructions such as those described herein since a cylinder having an inside sleeve valve will require the use of a connecting rod connected to a crank the center of rotation of which must be further away from the end of the cylinder than is the case in the constructions herein described. This is for the reason that clearance must be provided between the connecting rod and the outer end of the cylinder at the positions of extreme angularity of the connecting rod, and when a sleeve valve is positioned within the cylinder less angularity will be permitted to the connecting rod unless the diameter of the cylinder is correspondingly increased. Accordingly my construction permits the use of cylinder and crank case members having less weight and smaller outside dimensions than is the case with engines having inside sleeve valves.

It should be understood that while I have described certain forms and features of the invention with particularity, the invention is not limited to the exact details which have been described, but that various modifications may be employed as will be clear to those skilled in the art after reading this specification, the scope of the invention being indicated by the accompanying claims.

What I claim is:

1. In an internal combustion engine, the combination of a cylinder having an end wall with an opening therein, a cylinder head member upon said end wall having a transverse bore therein, a stationary conduit member having a curved surface in said bore having an opening in the wall thereof, a partial sleeve valve between said end wall and conduit member, and having an opening therein, said valve having a surface slidably mounted on said end wall and an opposite surface fitting partly about said conduit member, and means for sliding said valve longitudinally, intermittently, to cause said openings in said end wall, conduit member and valve to align at suitable times and to be out of alignment at other times.

2. In an internal combustion engine, the combination of a cylinder having an end closure with an opening therein, a cylindrical conduit member extending transversely across said closure and having an opening in a wall thereof, a valve member interposed between said closure and conduit member and having an opening therein, said valve member having a surface slidably mounted on said end closure and an opposite surface fitting partly about said conduit member, and means for intermittently sliding said valve member longitudinally, to cause the openings in said cylinder closure, valve member and conduit member to align at suitable times, and to be out of alignment at other times.

3. In an internal combustion engine, the combination of a cylinder having an end closure with a trough of curved section extending across the outer surface thereof and having an opening therethrough, a cylindrical conduit member extending transversely across said closure and having an opening in a wall thereof, a partial sleeve valve of crescent shaped cross section interposed between said closure and conduit member and having an opening therein, opposite surfaces of said valve being slidably mounted within said trough and against said conduit member, and means for intermittently sliding said valve member longitudinally, to cause the openings in said cylinder closure, valve member and conduit member to align at suitable times, and to be out of alignment at other times.

4. In an internal combustion engine, the combination of a cylinder having an end wall with inlet and exhaust ports therethrough, parallel partial sleeve valves slidably mounted on the outside of said wall to control said ports, respectively, means for sliding said valves intermittently, to open and close said ports at suitable times, and conduit means for carrying fresh charge to the inlet port, and for conducting exhaust gases from the exhaust port, respectively, when the same are uncovered, said valves having surfaces slidably mounted on said end wall and opposite surfaces fitting partly about said conduit means.

5. In an internal combustion engine, the combination of a cylinder having an end closure with an opening therethrough, a cylinder head structure extending outwardly from said closure, with a bore therein transverse to the axis of said cylinder, a cylindrical member in said bore, having a cam groove thereabout, a slide valve between said cylindrical member and closure, for controlling said opening, and having a pin extending into said groove, and means for rotating said member to reciprocate said valve.

6. In an internal combustion engine, the combination of a cylinder having an end closure with an opening therethrough, a cylinder head structure extending outwardly from said closure, with a bore therein transverse to the axis of said cylinder, a cylindrical member in said bore, having a cam groove thereabout, a slide valve between said cylindrical member and closure for controlling said opening, and having a pin extending into said groove, a conduit member in said bore in alignment with said cylindrical member, serving to hold said valve to its seat and having an opening therein, and means for rotating said cylindrical member to reciprocate said valve to establish communication between said cylinder opening and said conduit member opening at times, and to close such communication at other times.

7. In an engine, the combination of a port-

ed surface, having a troughed seat therein, a stationary member outside said surface having a convex surface directed towards said first surface, with a passage extending through its said convex surface, a slide valve of curved section fitted between said troughed seat and convex surface, and means for reciprocating said valve to establish and disestablish communication between the port of said ported surface and said passage.

In testimony whereof I have signed my name to this specification, at New York, N. Y., on this 16th day of May, 1922.

CHARLES J. TÓTH.