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TWO-STROKE CYCLE INTERNAL COMBUSTION ENGINE

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Fig. 1

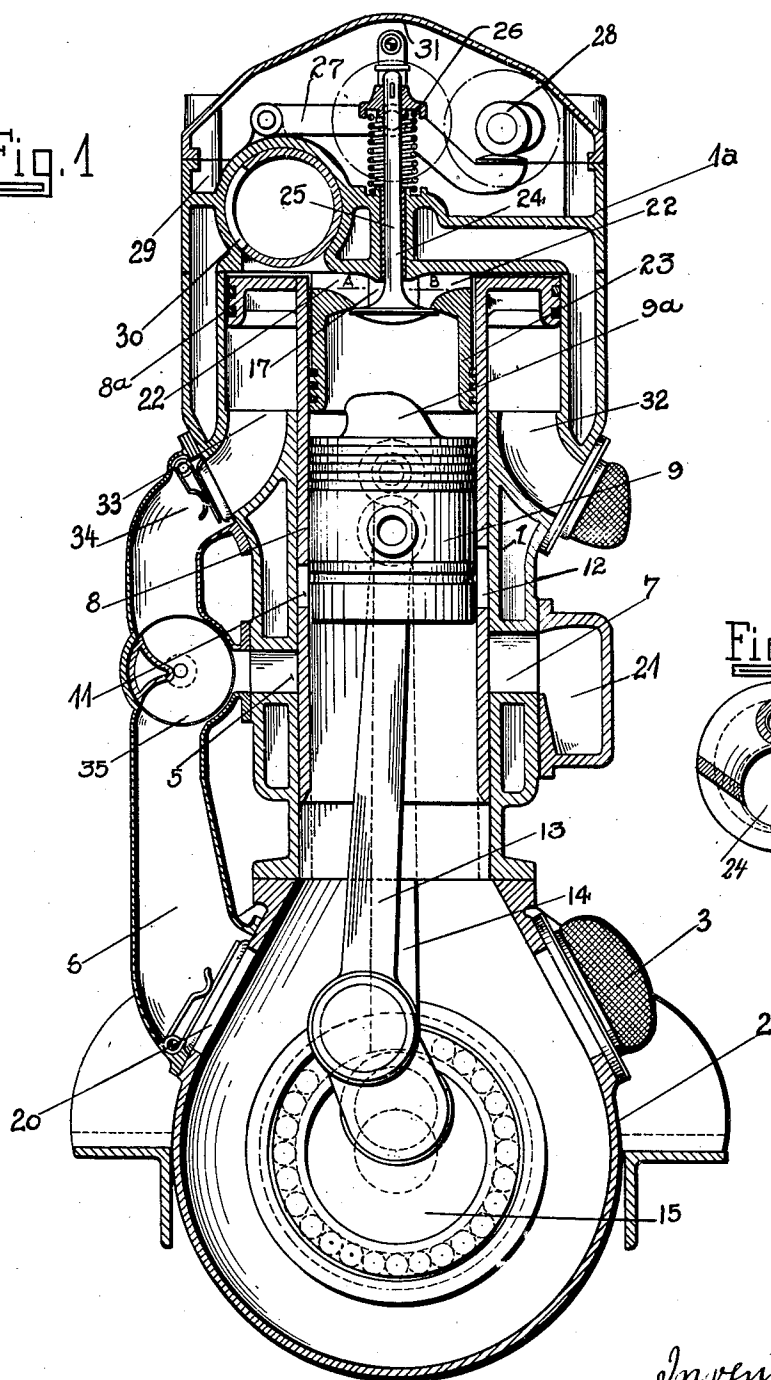
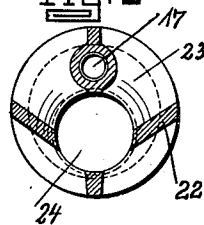


Fig. 2



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TWO-STROKE-CYCLE INTERNAL-COMBUSTION ENGINE

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The present invention relates to a two-stroke cycle internal combustion engine having separate air and fuel admission and provided with a movable cylinder and a working piston operating within said movable cylinder and moving in the same direction with regard to the stationary parts as the said movable cylinder, of the type described in my prior application, Serial No. 218,348 filed on September 8, 1927.

In the type of engine described in the said application, the combustion space is first fully charged with air and the whole contents of the fuel pump are then fed into the charge. The engine according to the said prior application differs from the known engines having a movable cylinder and a working piston moving in the same direction with regard to the stationary parts as the said movable cylinder in that the combustion space is arranged between the movable cylinder and the movable piston. The movable cylinder thus constitutes the combustion cylinder. The said movable cylinder is provided with a broad upper part which serves as a piston for the fuel pump. An automatically operating valve is arranged in the said movable cylinder, through which valve the transmission of the contents of the pump into the working space during the compression operation takes place.

Since the movable cylinder and the movable piston move as aforesaid in the same direction, the connecting rods have to be connected to the crank disc pivotally in such a manner that their crank pins lie approximately or absolutely in the same radial plane; their stroke is however, not the same and in fact the stroke of the movable cylinder should amount approximately only to a third of the stroke of the working piston. The combustion which takes place between the movable cylinder and the working piston operates on the said movable cylinder in the opposite direction to that in which it acts upon the working piston, and therefore decreases the work performed by the working piston to the extent of about one third.

It is the principal object of the present invention to eliminate this counter effect of the

combustion on the movable cylinder in order that the full power should be obtained from a given charge or surcharge of fuel subject only to the ordinary losses resulting from friction.

According to the invention this is attained by constructing the movable cylinder which hitherto has taken the form of a closed cylinder, as a cylinder having a bore at its upper end through which a fixed cover which is provided with ports and is cast on the fixed cylinder cover projects, said cover for the movable cylinder penetrating into the movable cylinder to an extent greater than the length of the stroke of the movable cylinder. This fixed cover for the movable cylinder renders it possible to replace the automatic valve employed in the previous construction by a control valve and likewise arrange the sparking plug in the said fixed cover so that the sparking plug remains continuously in contact with the combustion space.

A preferred constructional form according to the invention is illustrated in the accompanying drawing, in which:

Fig. 1 is a longitudinal section of a two-stroke cycle internal combustion engine and Fig. 2 is a cross section on line A—B of Fig. 1.

The reference numeral 1 denotes a stepped cylinder to the lower part of which a crank case 2 is connected. The crank case 2 is provided with an opening controlled by means of a suction valve 3 and with a second opening which is normally held closed by means of a compression valve 20 from which last named valve a conduit 6 is led to an opening 5 provided approximately at the middle of the narrow part of the stepped cylinder. Opposite to the opening 5 an opening 7 connected to an exhaust pipe 21 is provided in the stepped cylinder. In the narrow part of the stepped cylinder 1 a movable cylinder 8 is guided which is provided at its upper end with a flange 8* guided in the broad stepped part of the cylinder 1. The working piston 9 moves in the movable cylinder 8. In the movable cylinder 8 two bores 11, 12 arranged oppositely to one another are provided, which bores come into register in the correspond-

ing position of the cylinder 8 with the openings 5, 7 of the cylinder 1. To the outer side of the cylinder 8 two connecting rods 14 are attached the other ends of which are pivotally attached to the crank disc 15. The pins by means of which the connecting rods 14 are pivotally connected to the cylinder 8 project in known manner through slots in the cylinder 1 the said two connecting rods 14 lying laterally outside the closed crank case but being at the same time easily accessible and suitably protected. The connecting rod 13 of the piston 9 is pivotally connected to the crank disc 15 in such manner that its crank pin lies approximately in the same radial plane as the crank pin shown in dotted lines of the connecting rod 14, but the piston 9 has a stroke approximately three times as large as that of the cylinder 8.

On the cylinder cover 1^a a fixed piston cover 23 is provided which is arranged on the under side of the said cover and is connected with the latter by means of ribs 22 and which projects from above into the inner bore of the cylinder 8 and is provided at its lower end with piston rings.

The piston cover 23 is cup-shaped and is provided in its upper part below the admission ports with an opening which is normally held closed by a valve 24. The valve 24 is provided with a valve spindle 25 which passes through the cylinder cover 1^a and the said valve is normally pressed upwards by means of a spring 26. The valve 24 is controlled by means of a swinging lever 27 arranged on the cylinder cover 1^a by the aid of a cam disc 28.

In the cover of the cylinder the fuel inlet 29 is arranged the connection of which with the space outside of the valve 24 is controlled by means of a rotary slide valve 30. The rotary slide valve 30 has the same transmission ratio as the cam shaft and is driven from the crank shaft by means of a governor shaft. The controlling gear is, as usual, protected by means of a protecting cover 31.

The space in the cylinder 1 within which the flange 8^a moves is closed at its lower end except for two openings 32, 33, the first of which is closed by means of a suction valve, whilst the second is closed by means of a pressure valve. A pipe 34 is connected with the opening 33 which pipe connects with the previously mentioned pipe 6 at the height of the opening 5 in the cylinder 1. At the point of connection of the pipes 6, 34 a rotary throttle valve 35 is provided the control segment of which is adapted to cover the pipe 34 or the pipe 6 or the opening 5.

The sparking plug 17 is arranged in a screwed bore of the fixed cover 23 for the movable cylinder. In order to allow sufficient space for the valve 24 and the sparking plug 17 in the fixed cover 23 both of these

are arranged outside of the centre of the said cover (see Fig. 2).

The mode of operation of the engine is as follows:

Assuming that the movable cylinder 8 and the piston 9 are in their highest positions, then on the descent of the said cylinder and piston the fuel inlet 29 is opened by the rotary slide valve 30, so that the cylinder 8 sucks in fresh fuel in its downward movement. In consequence of the different strokes of the movable cylinder and the working piston, these latter displace themselves with regard to one another during the rotation of the crank disc 15, whilst moving, however, at least for the greater part of the stroke in the same direction. During the downward movement of the movable cylinder and the piston a compression of air takes place not only in the crank case but also below the piston 8^a, which compression takes effect in the conduits 6 and 34. Shortly before the termination of the downward movements of the cylinder and the piston the openings 11 and 12 of the cylinder 8 come into register with the openings 5 and 7 of the cylinder 1. As soon as the piston 9 in its movement relatively to the cylinder 8 has opened the openings 11 and 12 which it controls, the compressed air present in the pipes 34 and 6 penetrates through the opening 11 into the interior of the cylinder, the space within which is limited by the internal bore of the cylinder 8, the piston 9 and the fixed cover 23. Any waste gases which may be present in this space as a result of previous working operations are thus driven out through the opening 12 into the exhaust pipe 21. The scavenging air admitted in this way may be directed by means of a baffle plate 9^a arranged on the piston 9 in such manner that a thorough scavenging is effected. In consequence of the ample supply of air in the pipes 6 and 34 the content of which is equivalent to double the cylinder content the effect produced is not only a scavenging operation, but in addition to this the space between the piston 9 and the fixed cover 23 becomes completely filled with fresh air. On the upward return movement of the movable cylinder and the piston the piston 9 after moving a short distance closes in the first place the openings 11, 12 and retains in the interior of the cylinder a charge of air corresponding volumetrically to the normal charge for the two-stroke cycle, which charge, however, only consists of air. The rotary slide valve 30 will have shut off the fuel admission inlet 29 towards the end of the downward movement of the cylinder and piston. The fuel which has been drawn in is compressed on the upward movement of the piston 8^a and after the valve 24 has opened is further compressed in the space between the fixed cover 23 and the working piston 9, i. e. in the interior of the cylinder. The valve

24. opens just when the ascending piston 9 passes over the openings 11, 12 so that any loss of fuel is impossible. The volume of the fuel pump is so calculated that besides the charge of air already existent in the interior of the cylinder a further full charge of fuel corresponding to the undiminished content of the cylinder is pumped in. Towards the end of the upward movement of the piston 9 and whilst the cylinder 8 is just passing through the upper dead centre, the valve 24 closes. At this moment the sparking plug 17 effects the ignition of the highly compressed standard mixture. The combustion pressure operates to the full extent on the working piston 9 and the loss of one third of the power which occurred in the construction according to the prior application above mentioned is avoided. The sequence of operations then repeats itself as before. It will, of course, be obvious that the power of an engine of the kind now described will be greater than that of an engine constructed in the manner set forth in the said prior application, inasmuch as the opposing power of the cylinder 9 is avoided, whilst at the same time the advantages of a volumetrically equally great charge or surcharge are retained. Besides this, an excess of air is available for the scavenging and the preliminary charging with air.

The mode of operation of the two-stroke cycle engine according to the present invention is also thermo-dynamically better than that of a four-stroke cycle engine inasmuch as, apart from the fact that it is possible to overcharge the engine to an extent of 100% and more as compared with ordinary two-stroke cycle engines, the engine—like a four-stroke cycle engine,—does not give rise to the slightest loss of fuel. Again apart from this, a scavenging operation with double the volume of air as compared with the content of the cylinder takes place between each combustion operation whereby, apart from the higher compression in the compressor and the consequent thermo-dynamical improvement of the charge, the said scavenging operation alone results in a considerable improvement of the charge at the outset, whereas, as is well known in four-stroke cycle engines no air scavenging takes place at all.

As in the case of the engine constructed according to the aforementioned prior application, so also in the case of the engine according to the present invention, the compressor action can be shut off if the rotary throttle valve 35 is set in such a position that it closes the opening 5 for the admission of air. The engine then works as a normal two-stroke cycle engine. The rotary throttle valve 35 is preferably coupled with the two suction valves 32 and 33 in such manner that when the air inlet 5 is shut off by the rotary throttle valve the said air suction valves are

automatically kept open. Even when running as a normal two-stroke cycle engine, the engine according to the invention develops considerably more power than a normal two-stroke engine and in fact develops double the power which would be developed by a four-stroke cycle engine having the same number of cylinders and the same cylinder contents, inasmuch as the engine when running in this last named manner receives similarly to four-stroke cycle engines a fuel charge corresponding to the full cylinder content, which charge is not diminished by any losses due to control by means of ports whilst at the same time in accordance with the two-stroke cycle combustion takes place at each revolution. By shutting off the air conduits 34, 6 or 5, to a greater or less extent by means of the rotary throttle valve 35, the scavenging air and the amount of the charge can be varied within wide limits. If several cylinders are combined to form an aggregate, it is frequently difficult to arrange to render the crank cases fluid tight in respect to one another. In this case it is preferable not to employ the crank case as a scavenging air pump but to leave the said case open as in the case of four-stroke cycle engines having a number of cylinders, and only to employ the air supplied by the piston 8^a the volume of which is, in any case, greater than that provided according to the normal two-stroke cycle charge, so that in this case also the engine operates with an excess of air as compared with the first operative air charge.

I claim:

1. In a two stroke-cycle internal combustion engine the combination of: a stationary cylinder provided with a removable cover and having a crank case attached to it; a movable cylinder provided with a flange at one end and slidably mounted within said stationary cylinder, said movable cylinder being driven from the crank shaft of the engine; a fixed cover for said movable cylinder arranged on the under side of said removable cover and carried by ribs attached thereto, said fixed cover projecting from above into said movable cylinder and said movable cylinder sliding on the projecting portion of said fixed cover; a working piston slidably mounted within said stationary cylinder and driven from the crank shaft of the engine in such manner that it moves in the same direction with regard to the stationary cylinder as that in which said movable cylinder moves, but with a stroke about three times as long as that of the latter; a fuel supply admission valve in said fixed cover; an exhaust port arranged in the lower part of said movable cylinder; an exhaust port in said stationary cylinder co-operating with said first-named exhaust port; an air inlet arranged in the lower part of said movable cylinder opposite to said first named

exhaust port; an air inlet in said stationary cylinder co-operating with said first-named air inlet; said movable cylinder being adapted to operate in conjunction with said fixed cylinder as a pump for the admission of fuel through said valve into said movable cylinder, and said piston being adapted to suck a supply of air into said crank case on the upward movement of said piston; a throttle valve adapted when fully closed to shut off completely the supply of said air under pressure so as to enable the engine to run as a normal two-stroke cycle engine.

2. In a two stroke cycle internal combustion engine, the combination of: a stationary stepped cylinder provided with a removable cover and having a crank case attached to it; a movable stepped cylinder provided with a flange at one end and slidably mounted within said stationary cylinder, said movable cylinder being driven from the crank shaft of the engine; a fixed cover for said movable cylinder arranged on the under side of said removable cover and carried by ribs attached thereto, said fixed cover projecting from above into said movable cylinder, and said movable cylinder sliding on the projecting part of said fixed cover; a working piston slidably mounted within said stationary cylinder and driven from the crank shaft of the engine in such manner that it moves in the same direction with regard to the stationary cylinder as that in which said movable cylinder moves, but with a stroke about three times as long as that of the latter; a fuel supply admission valve in said fixed cover; an exhaust port arranged in the lower part of said movable cylinder; an exhaust port in said stationary cylinder co-operating with said first named exhaust port; an air inlet arranged in the lower part of said movable cylinder opposite to said first-named exhaust port; an air inlet in said stationary cylinder co-operating with said first named air inlet; said movable cylinder being adapted to operate in conjunction with said fixed cylinder as a pump for the admission of fuel through said valve into said movable cylinder, and said piston being adapted to suck a supply of air into said crank case on the upward movement of said piston; a throttle valve adapted when fully closed to shut off completely the supply of said air under pressure so as to enable the engine to run as a normal two stroke cycle engine; the steppings of said stationary and said movable cylinder being so dimensioned that the suction space in the fixed cylinder is at least equal in volume to the content of the movable cylinder.

3. In a two stroke cycle internal combustion engine, a combination as specified in claim 1, in which the stepped part of the stationary cylinder is provided with air ports and the broader parts of the stepped stationary and movable cylinders are employed as

an air pump, the air pumped by the stepped parts of the said cylinders being employed together with the fresh air from the crank case pump.

4. In a two stroke cycle internal combustion engine, a combination as specified in claim 1, in further combination with: a spindle on said admission valve, means for grinding said spindle in the lower cover of said stationary cylinder, and a cam disc mounted on the cover of said stationary cylinder and adapted to control said valve.

5. In a two stroke cycle internal combustion engine, a combination as specified in claim 1, in further combination with a rotary slide valve adapted to control the fuel supply.

6. In a two stroke cycle internal combustion engine, a combination as specified in claim 1, wherein the broad stepped part of said fixed cylinder in which the flange of said movable cylinder moves is closed except for suction and compression ports at the bottom of said stepped part and is employed as a pump for the scavenging air.

Signed at Stuttgart, Germany, this 19th day of October, 1928.

GEORG BODEN.