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STARTING MECHANISM FOR INTERNAL COMBUSTION ENGINES.

APPLICATION FILED MAR. 12, 1914.

1,166,949.

Patented Jan. 4, 1916.

2 SHEETS—SHEET 1.

Fig. 1.

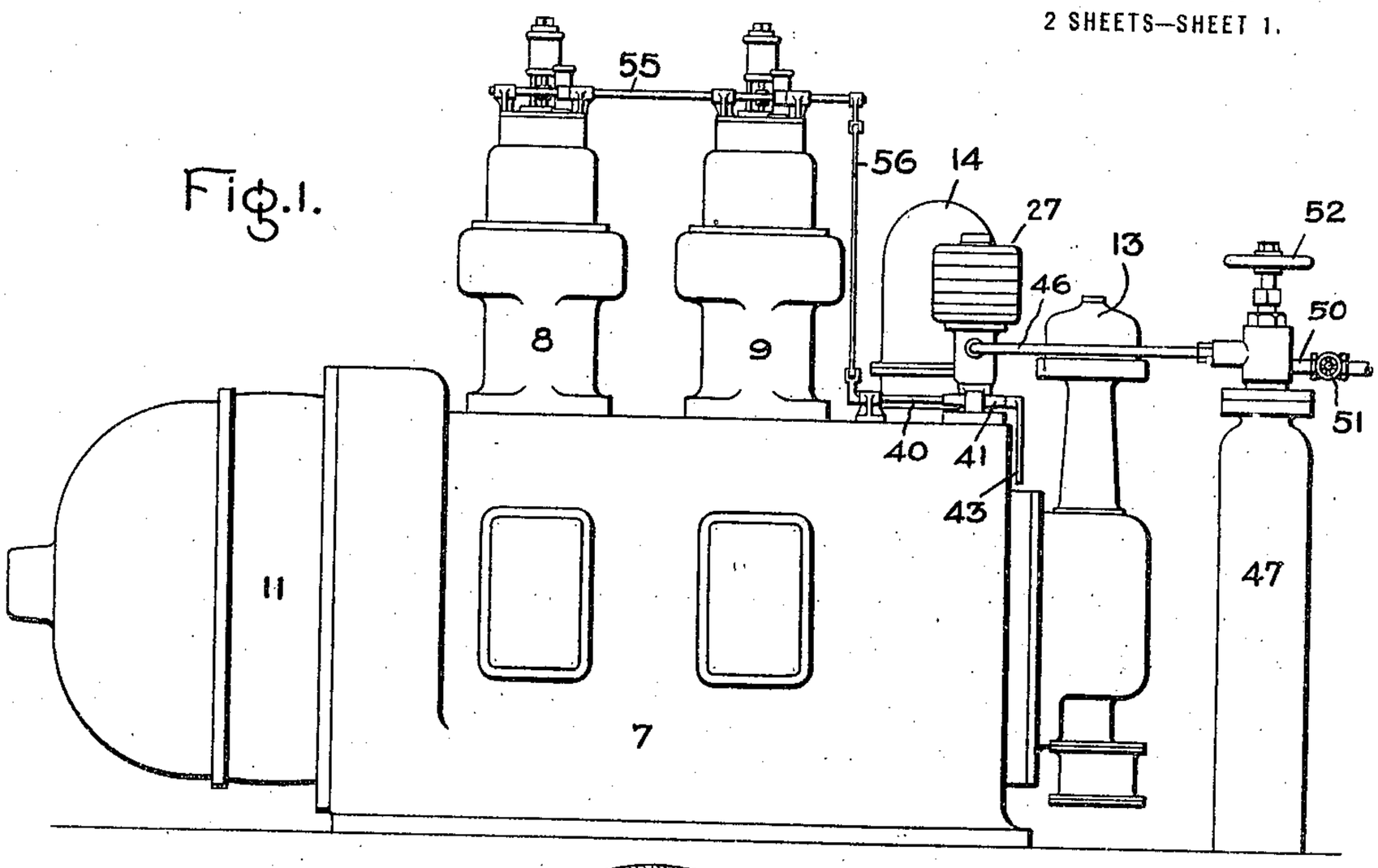





Fig. 2.

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2 SHEETS—SHEET 2.

Fig. 3.

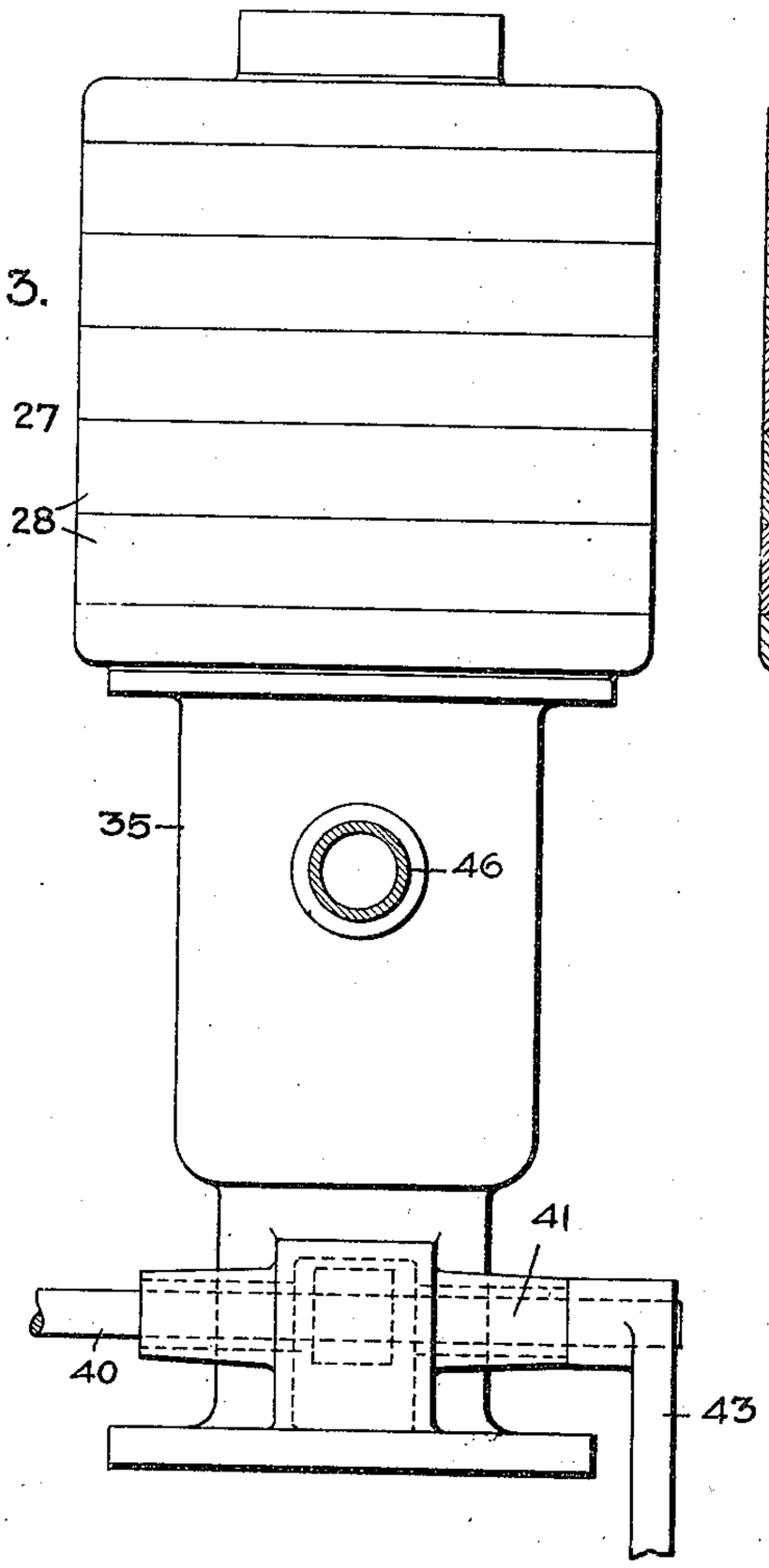



Fig. 4.

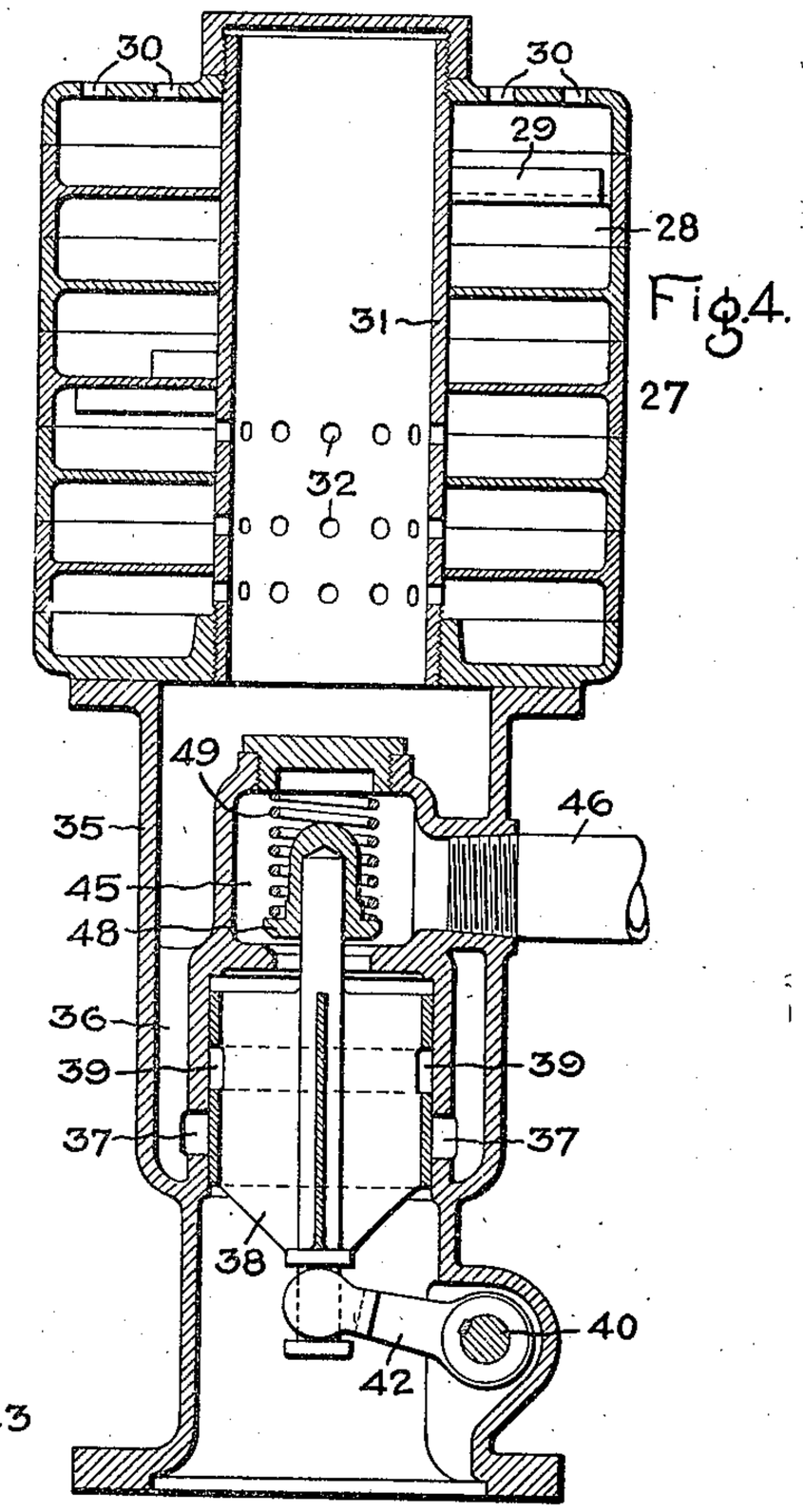



Fig. 5.

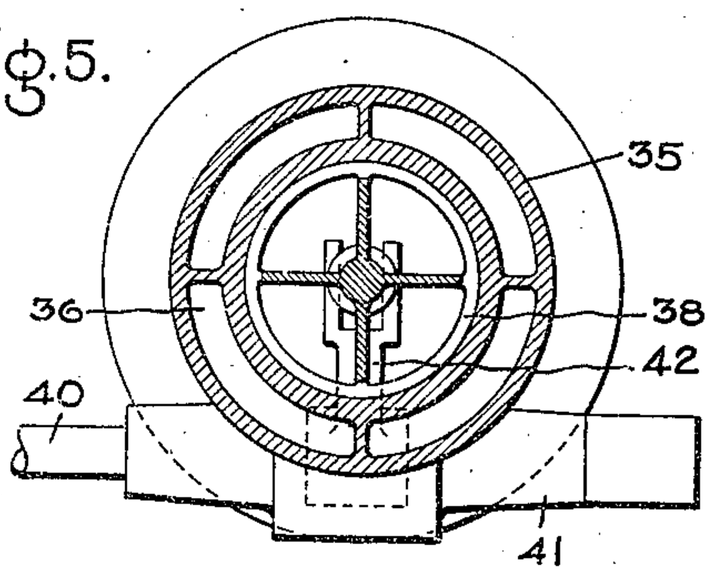
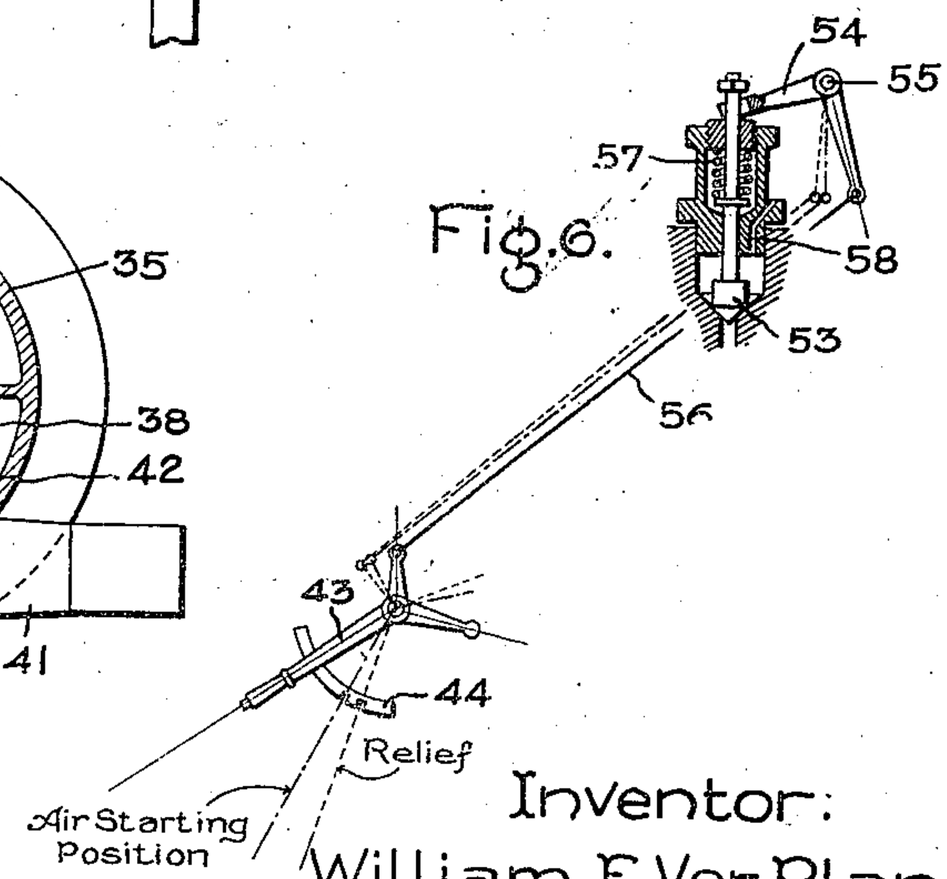



Fig. 6.

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# UNITED STATES PATENT OFFICE.

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## STARTING MECHANISM FOR INTERNAL-COMBUSTION ENGINES.

1,166,949. Specification of Letters Patent. Patented Jan. 4, 1916.

Application filed March 12, 1914. Serial No. 824,294.

*To all whom it may concern:*

Be it known that I, WILLIAM EVERETT VER PLANCK, a citizen of the United States, residing at Erie, county of Erie, State of Pennsylvania, have invented certain new and useful Improvements in Starting Mechanisms for Internal-Combustion Engines, of which the following is a specification.

The present invention relates to starting mechanism for internal combustion engines, and in particular to those operating on the high compression cycle. In such engines of the most improved type an air compressor is employed to supply the so-called "blast air" for injecting fuel into the working cylinder through a suitable injector. Fuel is supplied to the injector by a suitable pump which may be controlled by hand or by a speed governor, depending upon the character of the service for which the engine is intended. The air compressor is of the multi-stage type and is driven by the main shaft through suitable connections. In addition, a scavenging pump is also provided for scavenging the working cylinders of exhaust gases between firing strokes. This pump is usually double acting and of rather large diameter and supplies a large amount of air under relatively low pressure. The pump is controlled by a suitably timed valve means operated by the main shaft.

One object of my invention is to provide an improved arrangement whereby the engine can be started with air under moderate pressures, say 100 pounds per square inch for example, utilizing for this purpose the scavenging pump as an air motor. Owing to the relatively large diameter of the pump piston the air pressure need not be so high as where the starting air is admitted to a working cylinder or cylinders. I am also able by my improved arrangement to utilize the normal valve means of the pump.

A further object is to provide a simple reliable means operating in conjunction with the starting lever to reduce the compression pressure in the working cylinder or cylinders during the starting operation when for any reason it becomes necessary or desirable.

Briefly stated, in carrying out my invention I utilize compressed air from an intermediate stage of the compressor, which air is stored in a suitable vessel, said vessel being charged during normal operation by bleeding off some of the air passing through the compressor until a sufficient quantity is obtained. In starting I first shut off the atmospheric inlet of the scavenging pump by a separate valve and then admit by another valve compressed air from the starting vessel, the compressor valve means acting as usual to control the admission of air to and from the scavenging pump cylinder. The said shut-off and admission valves are not employed during normal operation, and are, therefore, in the nature of additions to the engine. Owing to their construction and arrangement the valves can be applied to existing engines without modification of the latter. The shut-off and admission valves are manually moved to and from starting position. If the engine stopped in a non-starting position its shaft should be barred over to the proper position. If the air pressure is too low to permit the scavenging pump, acting as a motor, to turn the engine over, due to the high compression in the working cylinders, a compression relieving valve for one or more of the cylinders is provided. This valve is controlled by the same handle or lever that closes the shut-off valve and opens the starting valve, said lever being so arranged that a slightly greater movement and in the same direction suffices for the purpose.

In the accompanying drawings, which illustrate one of the embodiments of my invention, Figure 1 is a view in side elevation of an engine operating on the high compression cycle; Fig. 2 is a vertical section of the scavenging pump and the valve mechanism therefor; Fig. 3 is a view in elevation of the suction silencer and the valve casing; Fig. 4 is a vertical section of the same; Fig. 5 is a cross-section through the atmospheric shut-off, and Fig. 6 is a diagrammatic view illustrating the action of the starting lever and compression reducing valve.

7 indicates the base of the engine and 8 and 9 the working cylinders mounted thereon. The main shaft 10 is arranged to drive the rotor of the electric generator 11, the casing for which is attached to the engine base.

13 indicates the casing of the speed governor, the latter being driven by a suitable shaft and gearing from the main shaft 10. Located at one end of the engine and surrounded by the casing 14 is a multi-stage

compressor and scavenging pump. The compressor is provided with a low pressure piston 15 and a high pressure piston 16. The lower end of the low pressure piston is enlarged to form the scavenging pump piston 17, the latter reciprocating in the cylinder 18. All of the pistons are actuated by the connecting rod 19 which is driven by a crank on the main shaft 10. The scavenging pump cylinder is provided with ports 20 and 21 located at opposite ends. These ports are controlled by a slide valve 22 which is actuated by an eccentric 23, shown in dotted lines, and the lever 24 and link 25. Under normal conditions air enters the slide valve from above and flows into the port 20 or 21 depending upon the position of the valve. 26 indicates a receiver for the air delivered by the scavenging pump. From the receiver air flows through ports in the cylinders at predetermined times to scavenge them.

The rapid movement of the pump piston causes the air to make considerable noise as it enters the machine. To reduce this, I provide a suction silencer 27 whose function is analogous to that of a muffler for the exhaust gases of the engine cylinder. As shown it comprises a structure containing a series of communicating cells 28. A part of the wall or partition between each two cells is cut away at some point and the partition adjacent the opening is provided with a lip 29, which registers with a corresponding lip on another partition. The openings between the cells are staggered so that the air has to follow a more or less zigzag path between the ports 30 where it enters and the slide valve 22 of the pump. The silencer is provided with a central tube 31 containing holes or ports 32 which communicate with the cells and through which air flows. The number of these holes progressively increases toward the point of final discharge. The silencer is mounted on a supporting casing 35 which rests on the frame of the engine directly over the slide valve. Inside of this casing are vertical passages 36 communicating with ports 37, the latter being normally open so that air after passing through the silencer is free to enter the pump subject to the control of the slide valve.

In order to utilize the scavenging pump as an air motor, it is necessary to shut off the admission of atmospheric air through ports 37. This is done by a tubular and ported slide valve 38 located in the support of the silencer. Under normal operating conditions the ports 39 of the valve register with the casing ports 37. In order to actuate the shut-off valve, a rock shaft 40 is provided and supported by suitable bearings 41 in the casing 35. These bearings should be so arranged as to prevent or at least to very greatly reduce the escape of air around the shaft. On the shaft and inside the casing is an arm 42 which extends between two collars on the valve spindle for moving it up and down. The rock-shaft is moved by a handle or lever 43 that moves over a quadrant 44, Fig. 6, which is provided with notches to receive the latch on the lever and hold the same in position. This lever has three positions as indicated by the dotted lines, Fig. 6.

In order to control the supply of compressed air to the pump when it is to be operated as an air motor and also to consolidate the valve means in one structure, and thus simplify the parts and reduce the cost of manufacture, the casing 35 above the shut-off valve is provided with a chamber 45 to which compressed air is admitted by the pipe 46, from the air storage vessel 47 as shown in Fig. 1. The escape of air from the chamber is controlled by a valve 48, Fig. 4, which is normally held against its seat by the pressure in the chamber and by the compression spring 49. The atmospheric shut-off valve 38 and the admission valve 48 are arranged to act successively, and in the opposite sense, that is to say, when the shut-off valve is closed the air supporting valve 48 is open and vice versa. This successive action of the valves is obtained in the present instance by arranging the stem of valve 38 to slide freely in the socket formed in valve 48. This provides in substance a lost-motion connection between them. The stem of valve 38 does not pick up valve 48 until it has first covered the ports 37. With the parts as shown in Fig. 4 compressed air is free to flow from the tank or vessel 47 through the opening from chamber 45 and valve 38 into the slide valve 22 from which it will enter one end of the pump cylinder or the other depending upon the position of the valve.

As it is undesirable to use the blast air on account of its high pressure and as it is desirable to avoid the work of compressing air to such a high degree, air for starting is taken from the first stage of the compressor by the pipe 50, the latter communicating with the starting vessel and containing a suitable controlling valve 51. Air from the compressor is bled off or by-passed until the vessel is filled, after which the valve 51 may be closed. The admission of air from the vessel to the engine is also controlled by the shut-off valve 52. Under ordinary conditions a pressure for example of about 100 pounds in the starting vessel will be sufficient.

Under certain conditions, for example, where the engine is very stiff or where the air pressure is low, or both, it is desirable to reduce the compression in one or more of the working cylinders. To this end, each cylinder may be provided with a relief valve 53 as shown more particularly in Fig. 6

which is normally held on its seat. In order to actuate it by the starting lever a bell-crank 54 is provided for each valve and the levers are connected by a rock shaft 55, which shaft is turned by the hand lever and connecting rod 56. The lever is so arranged that it may be moved to the broken-and-dotted line position marked "Air start position", without affecting the relief valve. If the engine does not start under these conditions the lever is pulled over to the dotted line position marked "Relief" and the bell-crank lever 54 will open the relief valve 53, it being understood of course that when the handle reaches the air starting position that it has closed the atmospheric shut-off valve 38 and opened the air supply valve 48. This means that some sort of a lost-motion must be provided between the lever 54 and the relief valve 53. It is best to arrange the valve 53 so that it opens outwardly from the cylinder, being normally held on its seat by a spring 57. In the casing is a port 58 through which compressed air can escape. With the parts thus arranged the valve 53 will open under any predetermined cylinder pressure thereby forming a safety v[illegible] in addition to functioning as a starting valve.

As will be seen my improved arrangement has the advantage of great simplicity and small cost, that air at moderate pressure may be used for starting, which air is obtained in an economical manner from the compressor during the ordinary operation of the engine. Also that since the atmospheric shut-off, air admission valve and silencer are combined in one structure they may readily be applied to or removed from the engine as a unit. The arrangement has the further advantage that the relief valve 53 only reduces the cylinder compression when it is found that the engine will not start without. As the compression relief valve is under the control of the same lever as the supply valve 48 the compression can be quickly restored as soon as the engine starts. This arrangement also reduces the liability of error on the part of the operator in putting the starting mechanism into and out of service.

In accordance with the provisions of the patent statutes, I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is only illustrative, and that the invention can be carried out by other means.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. An internal combustion engine, a scavenging pump driven by the engine shaft, and valve means for the pump controlling the admission of air to the pump cylinder and the discharge therefrom, in combination with a suction silencer, a valve for shutting off the normal admission port from the silencer to the pump, and a second valve actuated by the stem of the first for admitting fluid under pressure to the pump valve means to drive the pump as a fluid motor to start the engine.

2. An internal combustion engine, a scavenging pump driven by the engine shaft, and valve means for the pump controlling the admission of air to the pump cylinder and the discharge therefrom, in combination with a silencer, a valve for shutting off the normal admission port from the silencer to the pump, a second valve actuated through the stem of the first for admitting fluid under pressure to the pump valve means to drive the pump as a fluid motor to start the engine, and means for reducing the compression pressure in a working cylinder of the engine.

3. An internal combustion engine, a scavenging pump driven by the engine shaft, and valve means for the pump controlling the admission of air to the pump cylinder and the discharge therefrom, in combination with a valve for shutting off the admission of atmospheric air to the pump, a supply valve to admit fluid under pressure to the pump valve, a compression reducing valve for an engine cylinder, a lever which when moved to one position closes the shut-off valve and opens the supply valve and when moved in the same direction by a greater amount also opens the relief valve.

4. An internal combustion engine, a scavenging pump driven by the shaft of the engine, valve means for the pump controlling the admission of air to the pump cylinder and the discharge therefrom, in combination with a tubular and ported slide valve for shutting off the normal atmospheric admission port to the pump, and a second valve actuated by the stem of the first and timed to open after the first valve has been shut to admit air under pressure to the piston of said pump.

5. An internal combustion engine, a scavenging pump and a multi stage compressor driven by the shaft of the engine, valve means for the pump controlling the admission of air to the pump cylinder and the discharge therefrom, in combination with a valve which is open while the engine is running and through which atmospheric air is admitted to the pump, a receiving vessel connected to an intermediate stage of the compressor, a supply valve that is seated while the engine is running and controls the passage of air from the vessel, a means acting successively on the valves to first close the atmospheric valve and open the supply valve, and a compression reducing valve for an engine cylinder.

6. An internal combustion engine, a scavenging pump driven by the engine shaft, valve means for the pump controlling the admission of air to the pump cylinder and the discharge therefrom, in combination with a valve which is open while the engine is running and through which atmospheric air is admitted to the pump, a second valve that is seated while the engine is running and controls a source of compressed fluid, a means acting successively on the valves to close the first and open the second, and a third valve for reducing the compression in a working cylinder which is opened by the said means after the second valve has been opened.

7. An internal combustion engine, a scavenging pump driven by the engine, a slide valve for controlling the admission of atmospheric air to the pump cylinder and the discharge therefrom and a multi-stage air compressor, in combination with a vessel connected to receive and store air from an intermediate stage of the compressor, a valve for shutting off the admission of atmospheric air to the pump, a second valve for admitting air from the vessel to the pump subject to the control of the slide valve, and means for operating the two last named valves in succession.

8. An internal combustion engine, a scavenging pump driven by the engine, a slide valve for controlling the admission of atmospheric air to the pump cylinder and the discharge therefrom and a multi-stage air compressor, in combination with a vessel connected to receive and store air from an intermediate stage of the compressor, a valve for shutting off the admission of atmospheric air to the pump, a second valve for admitting air from the vessel to the pump subject to the control of the slide valve, means for operating the two last named valves in succession, and means for reducing the compression pressure in a working cylinder which is actuated by said means.

9. An internal combustion engine, a scavenging pump driven by the shaft of the engine, and valve means for the pump in combination with a silencer through which atmospheric air is admitted to the pump, a support for the silencer containing air ports and a fluid pressure chamber, a valve for shutting off the atmospheric ports for starting, a second valve controlling the passage of air from the chamber to the pump valve, and a means for actuating the two last named valves.

In witness whereof, I have hereunto set my hand this 10th day of March, 1914.

WILLIAM EVERETT VER PLANCK.

Witnesses:
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F. E. BLIVEN.