A. G. SCHOLES.

INTERNAL COMBUSTION ENGINE OF THE TWO-CYCLE TYPE.

APPLICATION FILED JUNE 14, 1909.

967,250.

Patented Aug. 16, 1910.

2 SHEETS—SHEET 1.

Fig. 1.

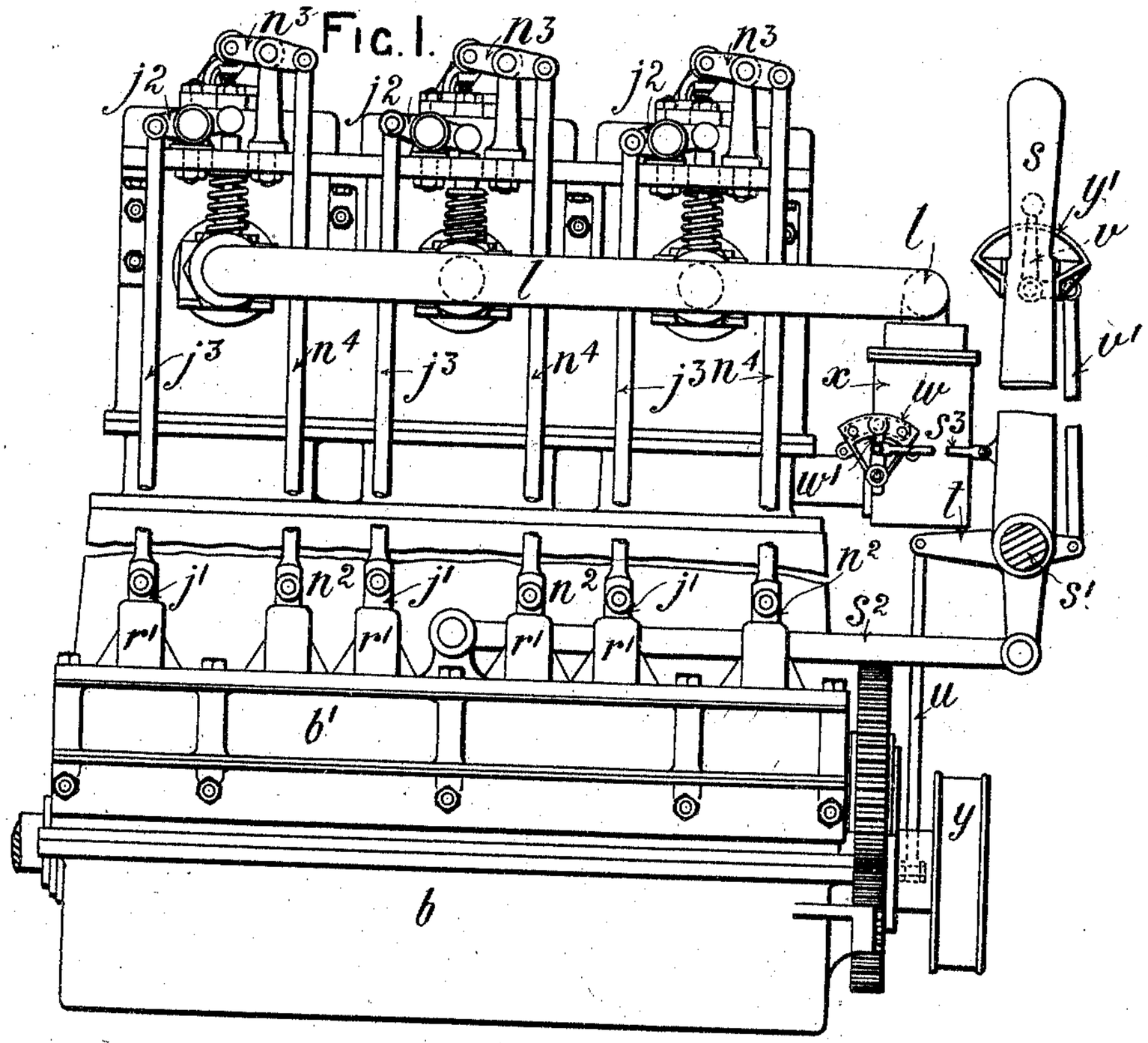
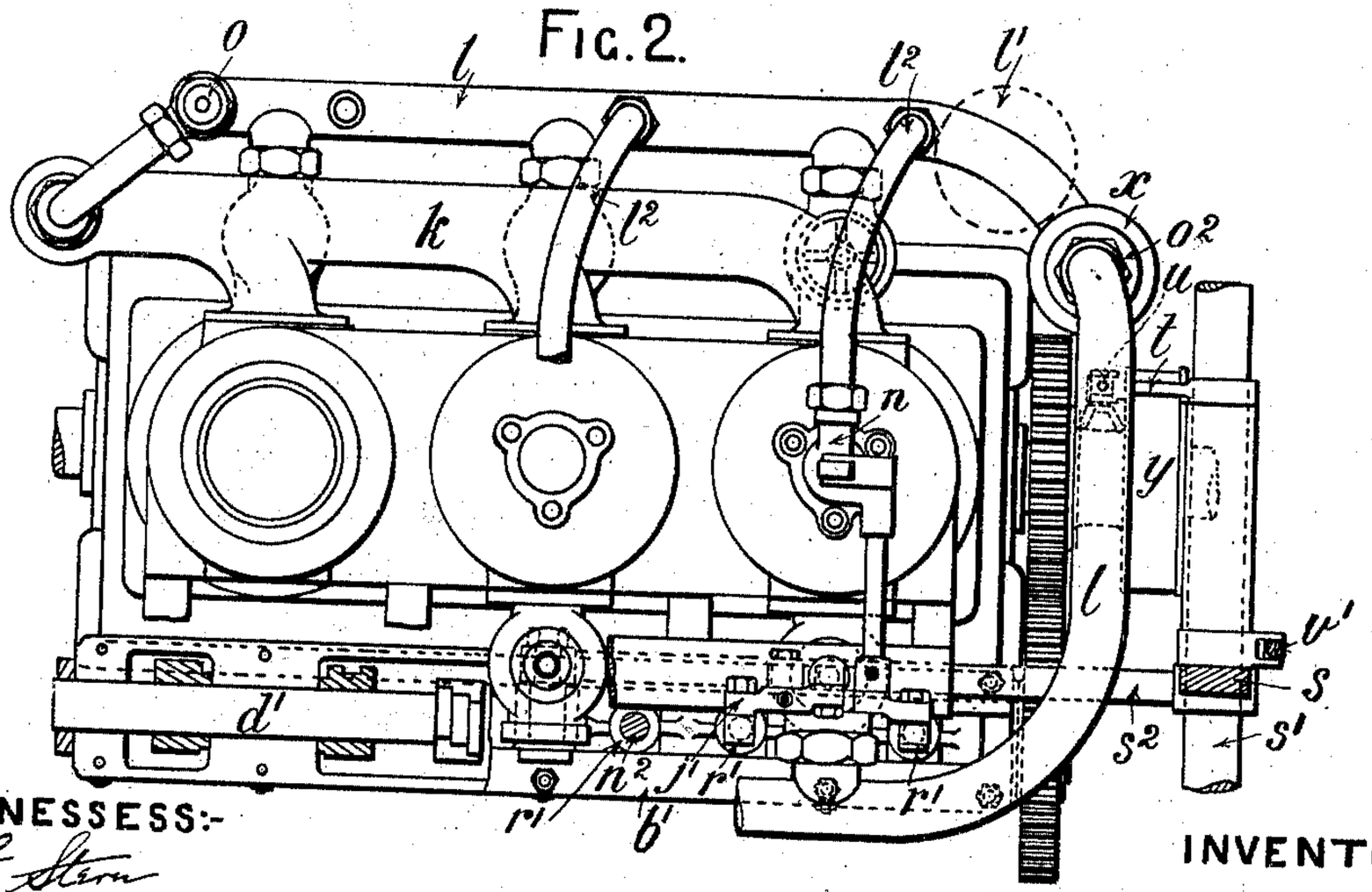


Fig. 2.



WITNESSES:-

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2 SHEETS—SHEET 2.

Fig. 3.

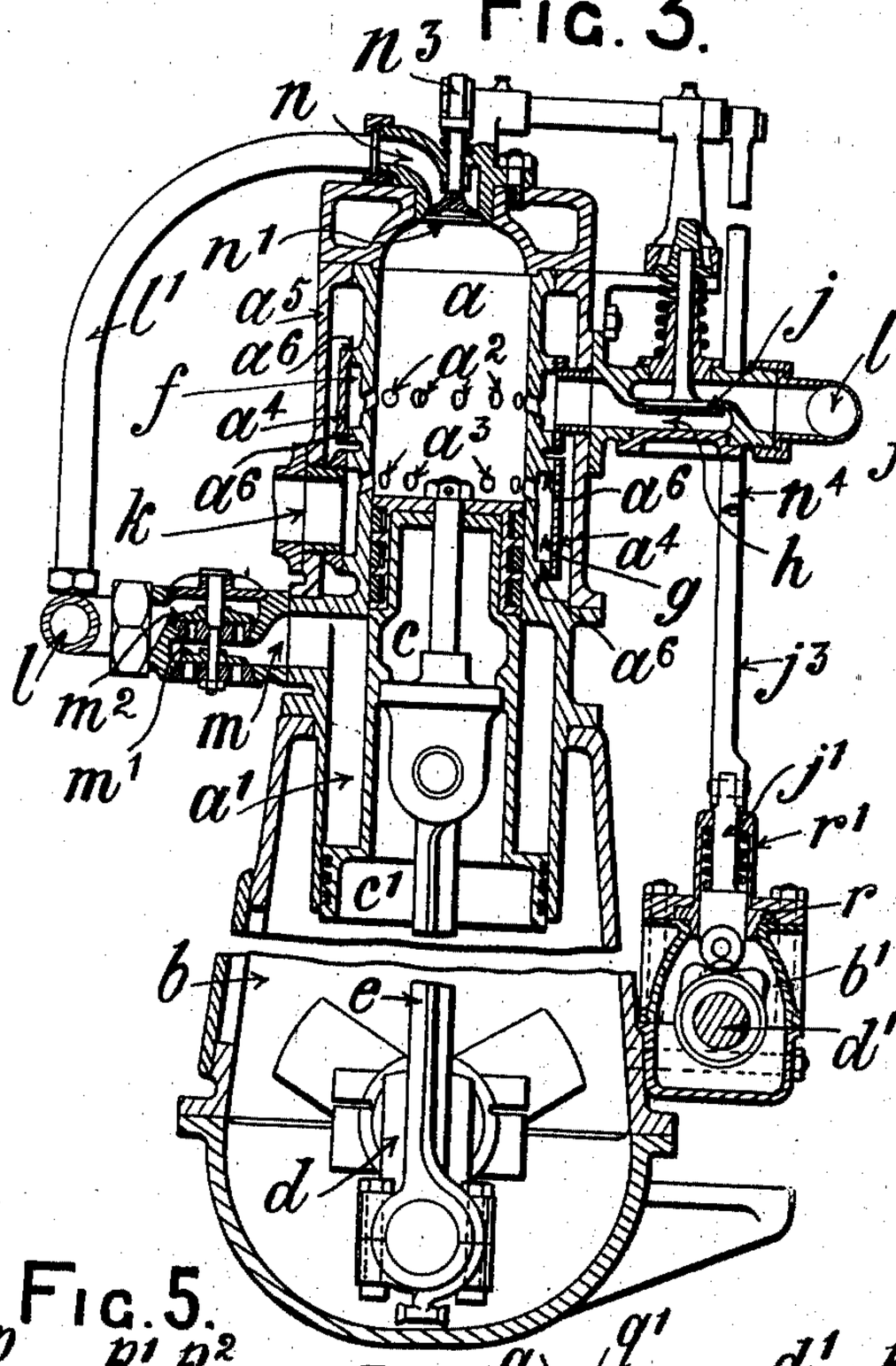


Fig. 4.

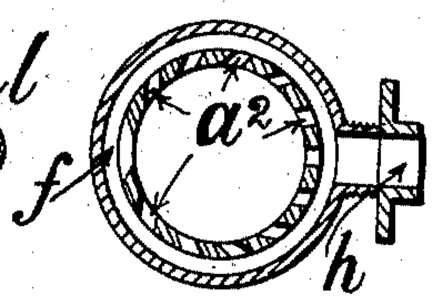


Fig. 8.

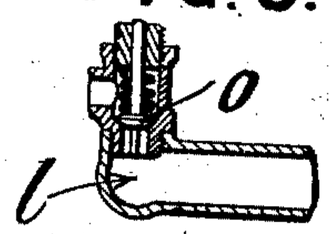


Fig. 9.

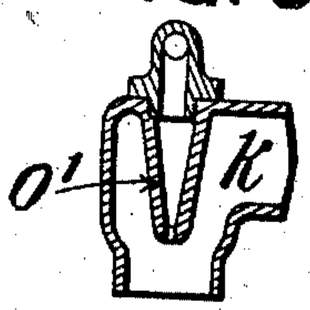


Fig. 5.

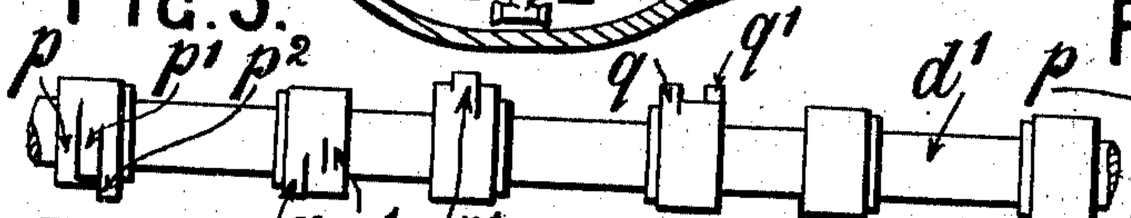


Fig. 6. Fig. 7.

Fig. 10.

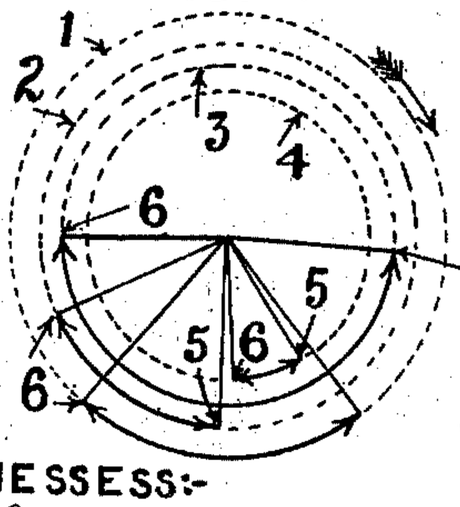


Fig. 11.

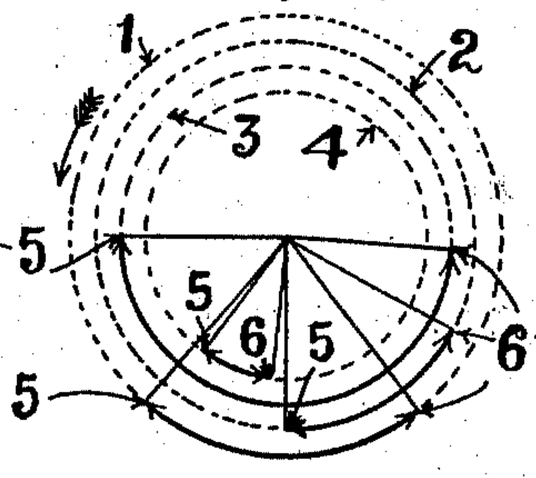
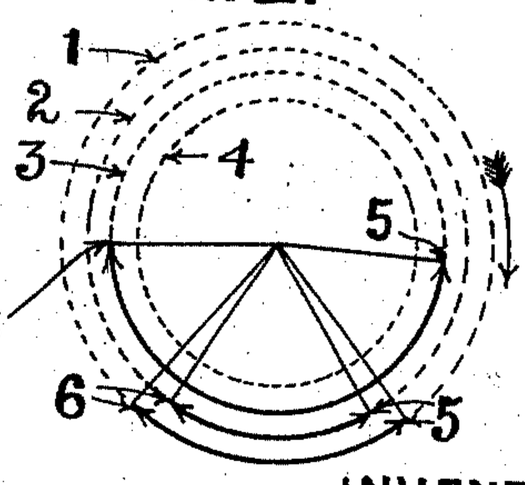


Fig. 12.



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UNITED STATES PATENT OFFICE.

ALFRED GEORGE SCHOLES, OF ILFORD, ENGLAND.

INTERNAL-COMBUSTION ENGINE OF THE TWO-CYCLE TYPE.

967,250. Specification of Letters Patent. Patented Aug. 16, 1910.

Application filed June 14, 1909. Serial No. 502,151.

To all whom it may concern:

Be it known that I, ALFRED GEORGE SCHOLES, a subject of the King of Great Britain and Ireland, residing at 41 Gordon road, Ilford, in the county of Essex, England, engineer, have invented a new and useful Improvement in Internal-Combustion Engines of the Two-Cycle Type, of which the following is a full and complete specification.

This invention relates to internal combustion engines of the two-cycle type; and the objects of my improvement are, first to obtain a more perfect scavenging of the cylinders of the products of combustion and thereby obtain an increased volume of charge, secondly to readily effect the reversal of the engine, and thirdly to generally increase the efficiency of this type of engine. I attain these objects by the construction illustrated in the accompanying drawings in which:—

Figure 1 is a broken view in side elevation of an engine with three working cylinders constructed according to this invention with the reversing lever in its mid or intermediate position, Fig. 2 is a view in plan thereof, Fig. 3 is a broken view in sectional elevation of one pair of the tandem cylinders with the duplex piston at the end of its outer or working stroke, and Fig. 4 is a view in transverse section through the induction ports of the working cylinder, Fig. 5 is a broken view in side elevation of the cam-shaft, Fig. 6 is a cross sectional view of the cam-shaft showing the cams for operating the inlet valve, Fig. 7 is a cross sectional view of the cam-shaft showing the cams for operating the scavenging valve, Fig. 8 is a sectional view showing the relief valve, Fig. 9 is a sectional view showing the air injector nozzle in the exhaust pipe, Figs. 10, 11 and 12 are diagrams showing the times the various valves and the like function, Fig. 10 showing when the reversing lever is set to cause the engine to run in a forward direction, Fig. 11 when the reversing lever is set to cause the engine to run in the reverse direction, and Fig. 12 when the lever is in a mid position to enable the engine to run in either direction. In these diagrams the operation of the exhaust is indicated on the dotted circle marked 1, that of the inlet valve on the dotted circle marked 2, that of the admission valve on the dotted circle marked 3, and that of the scavenging valve on the dotted circle marked 4, while 5 designates the time of opening and 6 the time of closing of the various ports. Throughout the other views similar parts are marked with like letters of reference.

Each of the working cylinders *a* has an extension—of larger diameter—toward the crank-chamber *b* forming a second cylinder a^1, hereinafter called the pumping cylinder. The piston is a duplex one the upper and smaller part forming the piston *c* of the working cylinder and the lower and larger part forming the piston c^1 of the pumping cylinder. The crank-shaft *d* is of the usual construction and its crank-pin is connected with the duplex piston by a suitable connecting rod *e*. In the engine illustrated in the drawings there are three cylinders but any lesser or greater number may be employed without departing from the spirit and scope of my invention.

In each of the working cylinders are two series of ports arranged around the entire circumference of the cylinder, one series a^2— located about three-fifths of the stroke down the cylinder—are the inlet ports and the other series a^3—located so that they are uncovered by the piston *c* just before it reaches the end of its outward stroke—are the exhaust ports. Each series of ports opens into an annular chamber *f* and *g* respectively, the said chambers being preferably located in the water jacket of the cylinder as shown. To the annular chamber *f* on one side of the working cylinder is connected a port or passage *h* in which is a mechanically operated valve *j*. To the annular chamber *g* on the other side of the working cylinder is connected the exhaust pipe *k*. The inlet ports a^2 are arranged as shown in Fig. 4 to facilitate the entrance of the charge into the cylinder, *i. e.* the port or ports immediately opposite to the port or passage *h* is or are arranged radially but each succeeding port on either side is arranged less and less radially and more and more tangentially. The inlet ports a^2 at or near to the induction port or passage *h* are drilled or formed at a slight angle to the horizontal plane and those ports diametrically opposite to said induction passage are drilled or formed at an increased angle so as to give the incoming charge an upward swirling action as it enters the working cylinder.

In the upper end of the pumping cylinder a^1 is a port or passage m containing a suction or air inlet valve m^1 and a delivery or non-return valve m^2 by which the air drawn into the pumping cylinder through the valve m^1 is discharged under pressure through the valve m^2 into a pipe l which is led and connected to the port or passage h. A reservoir l^1 may be located in the length of the pipe l but if the cubic capacity of said pipe is great enough the reservoir may be dispensed with.

In the upper part of the working cylinder a is a port or passage n closed by a mechanically operated valve n^1 the function of which is to admit air under pressure into the cylinder for scavenging purposes. This port or passage is connected with the air pipe l by means of a branch such as l^2. In the pipe l is a relief valve o which can be set to automatically keep the air in said pipe at a predetermined pressure and the surplus air which passes the relief valve is led by a suitable pipe or passage into an injector nozzle o^1 located in the exhaust pipe k as illustrated in Fig. 9.

In the pipe l between the connections of the branch pipe l^2 and the ports or passages h is introduced a carbureter x for liquid hydrocarbon—which may be of any suitable type—a convenient position being that shown in Figs. 1 and 2. On the delivery side of the carbureter a non-return valve o^2 may be fitted to prevent "firing-back" into the carbureter.

The annular chambers f and g are preferably formed by flanges a^6 arranged to form annular grooves around the cylinder, the said grooves being closed by sleeves a^4 mounted over and fixed to said flanges in any suitable manner to enable the inlet and exhaust ports to be drilled. In this construction the water jacket is formed by means of a detachable exterior sleeve or cylinder a^5 as shown in Fig. 3.

The valve j is operated through a lifter j^1, a rocking arm j^2, and a connecting rod j^3 by one or other of a series of cams p, p^1 and p^2 on the shaft d^1 which is driven from the crank-shaft through any suitable type of gearing at the same speed thereas. The valve n^1 is operated through a lifter n^2, a rocking arm n^3, and a connecting rod n^4 by one of two cams q and q^1 also on the shaft d^1, the distance apart of the cams q and q^1 being the same as that of the cams p and p^2 so that there is a neutral space between them. The lifters j^1 and n^2 work in guides r^1 formed on or carried by a plate r adapted to slide on or in the box b^1 carrying the shaft d^1 so that by sliding the said plate the lifters j^1 and n^2 can be brought into position to be operated by either of the cams of the series. The cams p and q are shaped to operate the valves j and n^1 for running the engine in a forward direction and the cams p^2 and q^1 for running the engine in the reverse or opposite direction. The cam p^1 is shaped to operate the valve j so that the engine will run in either direction, the object being primarily to reduce the power when reversing, but it may also be employed for normal working at reduced load.

The plate r is moved from one position to another by means of a hand lever s pivoted at s^1 in any convenient position in respect to said plate and coupled thereto by a link s^2. On the pivot s^1 is also mounted a lever t one end of which is connected to the commutator y—which is of any suitable type—by a link u and the other end of which is connected with a small bell-crank lever v pivoted to the hand lever s by means of a link v^1. The free end of the bell-crank lever v moves over a notched quadrant y^1 also carried by the hand lever s. The moving arm w^1 of a three-way switch w—placed in any suitable position in the circuit of the electric ignition system—is connected with the hand lever s by a link such as s^3.

The working cycle of the engine when running in a forward direction, *i. e.* with the cams p and q operating, is as follows:—Supposing the duplex piston to have reached the end of its inner or return stroke the compressed charge is fired by an electric spark or any other suitable system and the duplex piston commences its outward stroke being the working stroke of the piston c and the suction stroke of the piston c^1, the air being drawn into the cylinder a^1 through the valve m^1 and the port or passage m. When the piston c uncovers the exhaust ports a^3 the exhaust escapes through the said ports into the pipe k, and immediately the said ports are uncovered the scavenging valve n^1 is opened which admits air under pressure from the pipe l through the pipe l^1 into the cylinder which sweeps out the products of combustion, the said scavenging valve being closed when the piston c reaches the end of its outer or working stroke. At this point the inlet valve j is opened which admits a charge of explosive mixture of gas and air into the cylinder through the inlet ports a^2, the said charge being deflected upward in the cylinder by reason of the particular formation of said ports rises toward the top of the cylinder and operates to force the exhaust gases downward and out through the exhaust ports. As the piston c makes its inward or return stroke it closes the exhaust ports a^3 and at a predetermined time before the piston reaches the inlet ports a^2 the valve j is shut and the charge is compressed during the remainder of the inward or return stroke of the piston. The piston of the pumping cylinder a^1 on its inward to return stroke compresses the air drawn into the cylinder during the outward stroke and delivers it into the pipe l through the valve

m^2. To facilitate starting the engine in the first instance the pressure in the pipe l or the reservoir l^1 may be obtained by means of a hand pump. To reverse the engine the plate r is shifted by means of a hand lever s to bring the cams p^1 into operation and the cams q or q^1 out of operation, which has the effect both of reducing the power of the engine and retarding its running and cutting the scavenging valve n^1 out of action so that the reduced charge admitted by the valve j is used both for scavenging and charging. The plate r being shifted still farther brings the cams p^2 and q^1 into operation and the firing point being advanced at the same time by the movement of the lever s through the lever v the charge is fired much earlier and causes the engine to rotate in the opposite direction. The three-way switch w being in connection with the lever s the current is cut off momentarily while the lifters are passing from one cam to the other so that there is no possibility of pre-ignition.

What I claim as my invention and desire to secure by Letters Patent is:—

1. An internal combustion engine of the two-cycle type, comprising two cylinders of different diameters arranged tandem fashion the smaller being the working cylinder and the larger an air pumping cylinder, an admission port or passage in the working cylinder, a duplex piston working in said cylinders, a crank-shaft mounted in suitable bearings, a connecting rod for coupling the piston with the crank-pin of said shaft, two annular chambers around the working cylinder the one connected to the admission port or passage and the other connected to an exhaust pipe, a series of inlet ports in the working cylinder opening into the annular chamber connected to the admission port or passage, a series of exhaust ports in the working cylinder opening into the annular chamber connected to the exhaust pipe, a mechanically operated valve located in the admission port or passage, a suction port in the pumping cylinder, a suction valve in said port, a delivery port in the pumping cylinder, a delivery or non-return valve in said port, a port in the head of the working cylinder, a scavenging valve in said port, a pipe or passage connecting the delivery port of the pumping cylinder with the admission port or passage of the working cylinder, a carbureter in said pipe or passage, a branch from said pipe or passage leading to the scavenging valve, three cams for operating the inlet valve, two cams for operating the scavenging valve, lifters for communicating the motion of said cams to said valves, and means for bringing said lifters into contact with one or other of the duplex cams, as set forth.

2. An internal combustion engine of the two-cycle type, comprising two cylinders of different diameters arranged tandem fashion the smaller being the working cylinder and the larger an air pumping cylinder, an admission port or passage in the working cylinder, a duplex piston working in said cylinders, a crank-shaft mounted in suitable bearings, a connecting rod for coupling the piston with the crank-pin of said shaft, two annular chambers around the working cylinder the one connected to the admission port or passage and the other connected to an exhaust pipe, a series of inlet ports in the working cylinder opening into the annular chamber connected to the admission port or passage, said ports being arranged partly radially with and partly tangentially to said chamber, a series of exhaust ports in the working cylinder opening into the annular chamber connected to the exhaust pipe, a mechanically operated valve located in the admission port or passage, a suction port in the pumping cylinder, a suction valve in said port, a delivery port in the pumping cylinder, a delivery valve in said port, a port in the head of the working cylinder, a scavenging valve in said port, a pipe or passage connecting the delivery port of the pumping cylinder with the admission port or passage of the working cylinder, a carbureter in said pipe or passage, a branch from said pipe or passage leading to the scavenging valve, three cams for operating the inlet valve, two cams for operating the scavenging valve, lifters for communicating the motion of said cams to said valve, and means for bringing said lifters into contact with one or other of the duplex cams, as set forth.

3. An internal combustion engine of the two-cycle type, comprising two cylinders of different diameters arranged tandem fashion the smaller being the working cylinder and the larger an air pumping cylinder, an admission port or passage in the working cylinder, a duplex piston working in said cylinders, a crank-shaft mounted in suitable bearings, a connecting rod for coupling the piston with the crank-pin of said shaft, two annular chambers around the working cylinder the one connected to the admission port or passage and the other connected to an exhaust passage, a series of inlet ports in the working cylinder opening into the annular chamber connected to the admission port or passage, a series of exhaust ports in the working cylinder opening into an annular chamber connected to the exhaust pipe, mechanically operated valve located in the admission port or passage, a suction port in the pumping cylinder, a suction valve in said port, a delivery port in the pumping cylinder, a delivery valve in said port, a port in the head of the working cylinder, a scavenging valve in said port, a pipe or passage connecting the delivery port of the

pumping cylinder with the admission port or passage of the working cylinder, a carbureter in said pipe or passage, a branch from said pipe or passage leading to the scavenging valve, three cams for operating the inlet valve, two cams for operating the scavenging valve, lifters for communicating the motion of said cams to said valves, a sliding plate carrying the lifters of the valves, a hand lever for shifting said plate, an electric ignition system, a three-way switch with two neutral positions in the electric ignition system, and means for coupling the contact-making lever of said switch to the lever employed to shift the positions of the valve lifters, as set forth.

4. An internal combustion engine of the two-cycle type, comprising two cylinders of different diameters arranged tandem fashion the smaller being the working cylinder and the larger an air pumping cylinder, an admission port or passage in the working cylinder, a duplex piston working in said cylinders, a crank-shaft mounted in suitable bearings, a connecting rod for coupling the piston with the crank-pin of said shaft, two annular chambers around the working cylinder the one connected to the admission port or passage and the other connected to an exhaust pipe, a series of inlet ports in the working cylinder opening into the annular chamber connected to the admission port or passage, said ports being arranged partly radially with and partly tangentially to said chamber, a series of exhaust ports in the working cylinder opening into the annular chamber connected to the exhaust pipe, a mechanically operated valve located in the admission port or passage, a suction port in the pumping cylinder, a suction valve in said port, a delivery port in the pumping cylinder, a delivery valve in said port, a port in the head of the working cylinder, a scavenging valve in said port, a pipe or passage connecting the delivery port of the pumping cylinder with the admission port or passage of the working cylinder, a carbureter in said pipe or passage, a branch from said pipe or passage leading to the scavenging valve, three cams for operating the inlet valve, two cams for operating the scavenging valve, lifters for communicating the motion of said cams to said valve, and means for bringing said lifters into contact with one or other of the duplex cams, as set forth.

5. An internal combustion engine of the two-cycle type comprising two cylinders of different diameters arranged tandem fashion the smaller being the working cylinder and the larger an air pumping cylinder, an admission port or passage in the working cylinder, a duplex piston working in said cylinders, a crank-shaft mounted in suitable bearings, a connecting rod for coupling the piston with the crank-pin of said shaft, two annular chambers around the working cylinder the one connected to the admission port or passage and the other connected to an exhaust passage, a series of inlet ports in the working cylinder opening into the annular chamber connected to the admission port or passage, said ports being arranged partly radially with and partly tangentially to said chamber, a series of exhaust ports in the working cylinder opening into the annular chamber connected to the exhaust pipe, a mechanically operated valve located in the admission port or passage, a suction port in the pumping cylinder, a suction valve in said port, a delivery port in the pumping cylinder, a delivery valve in said port, a port in the head of the working cylinder a scavenging valve in said port, a pipe or passage connecting the delivery port of the pumping cylinder with the admission port or passage of the working cylinder, a carbureter in said pipe or passage, a branch from said pipe or passage leading to the scavenging valve, three cams for operating the inlet valve, two cams for operating the scavenging valve, lifters for communicating the motion of said cams to said valves, a sliding plate carrying the lifters of the valves, a hand lever for shifting said plate, an electric ignition system, a three-way switch with two neutral positions in said electric ignition system, and means for coupling the contact-making lever of said switch to the lever employed to shift the positions of the valve lifters, as set forth.

In testimony whereof I have signed my name in the presence of two subscribing witnesses.

ALFRED GEORGE SCHOLES.

Witnesses:

G. V. SYMES,

H. D. JAMESON.