A. B. E. CHEESEMAN & J. G. FLORENCE.

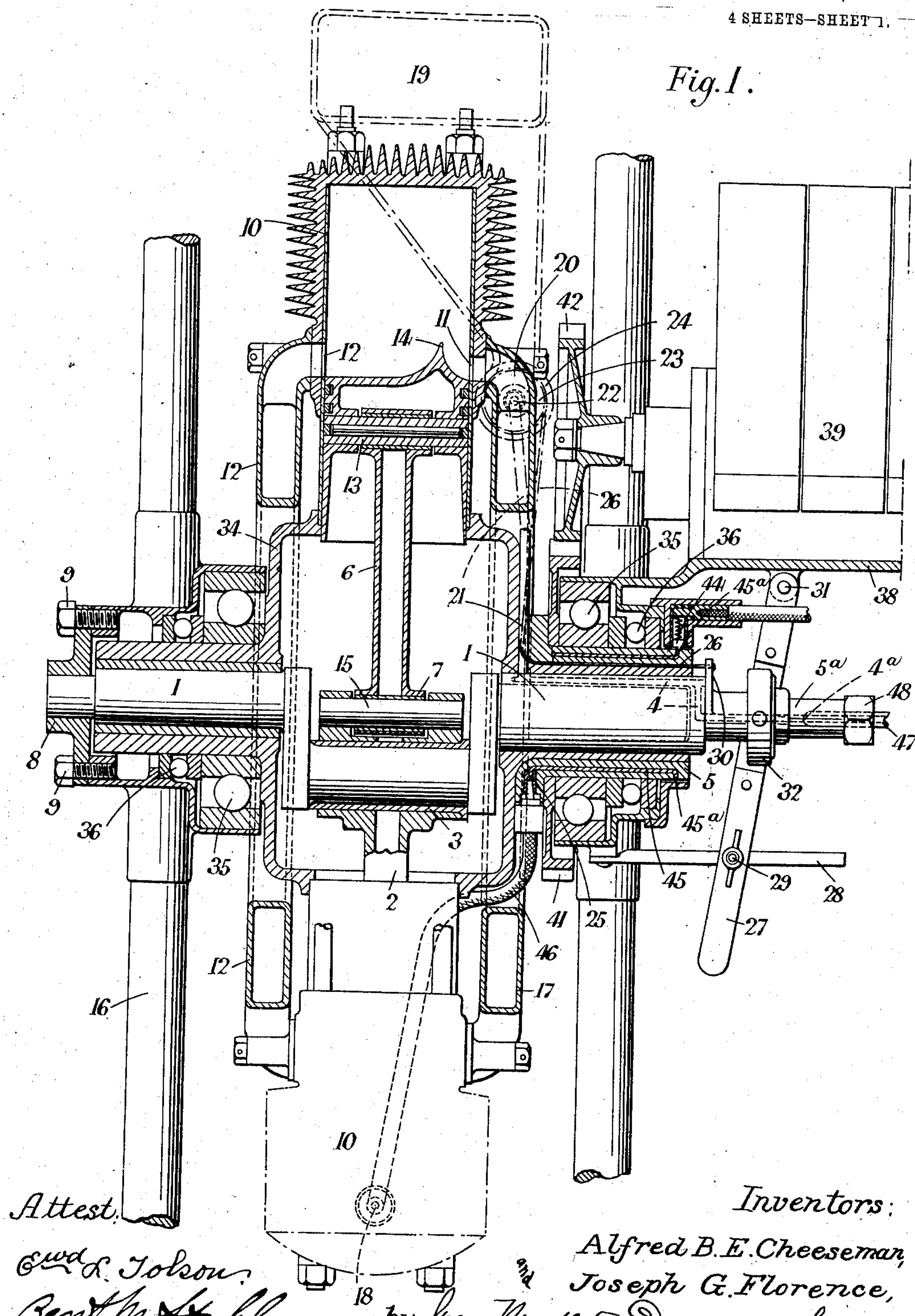
INTERNAL COMBUSTION ENGINE OF THE REVOLVING CYLINDER TYPE.

APPLICATION FILED MAY 27, 1911.

1,019,222. Patented Mar. 5, 1912.

4 SHEETS—SHEET 1.

Fig. 1.



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4 SHEETS—SHEET 2.

Fig. 2.

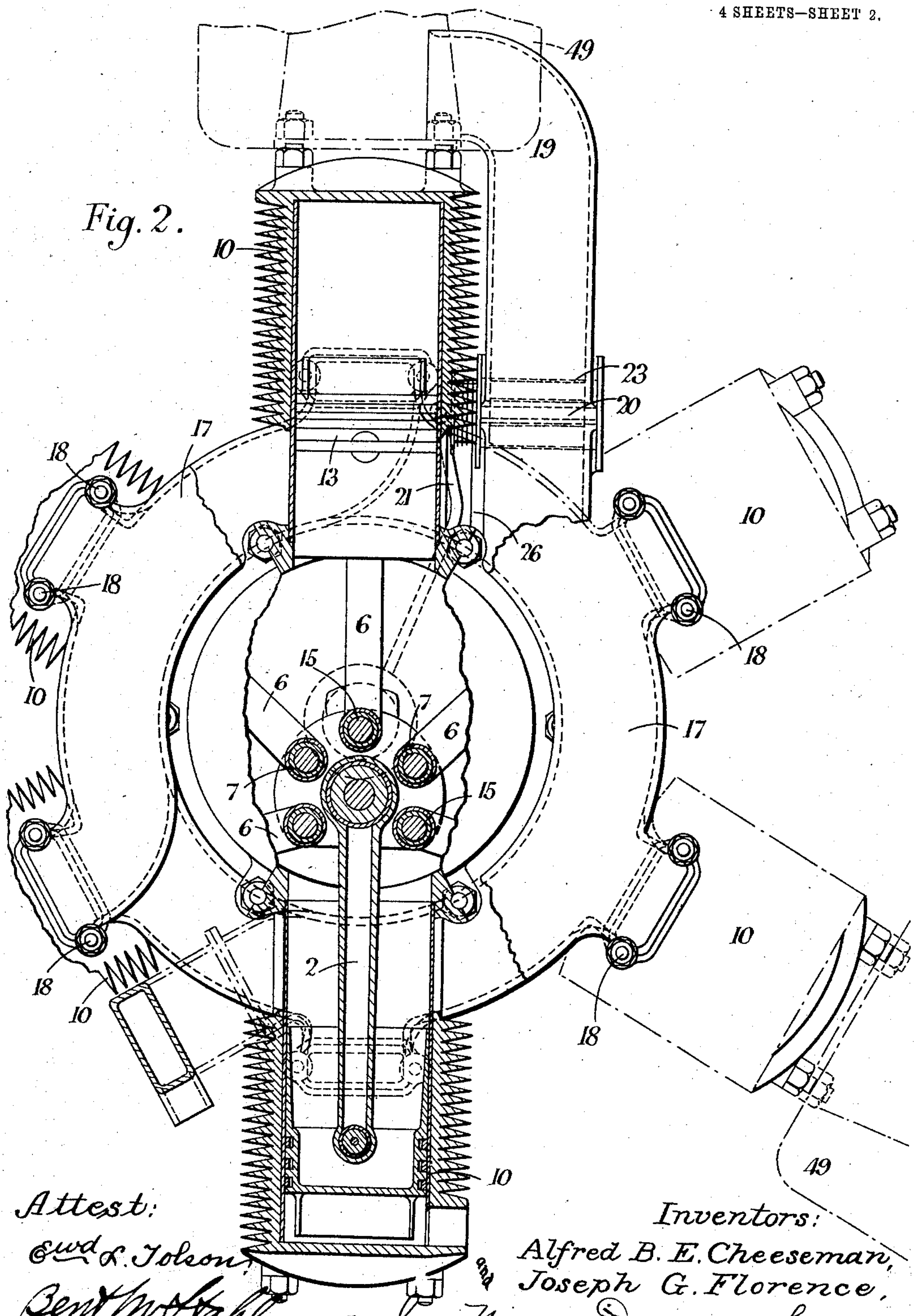

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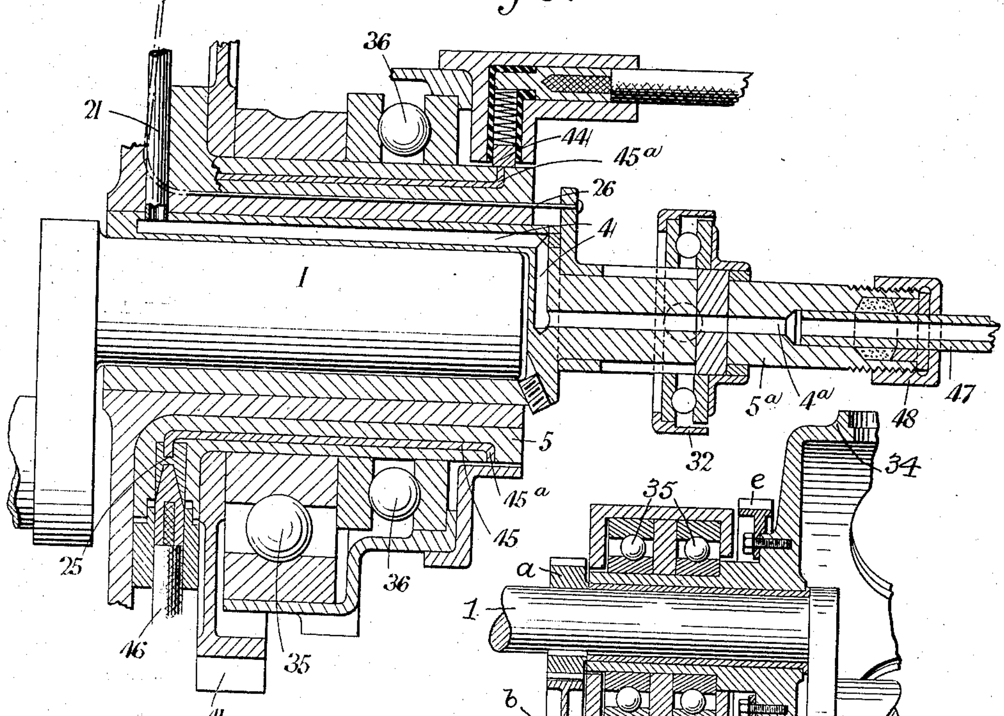
Fig. 3.



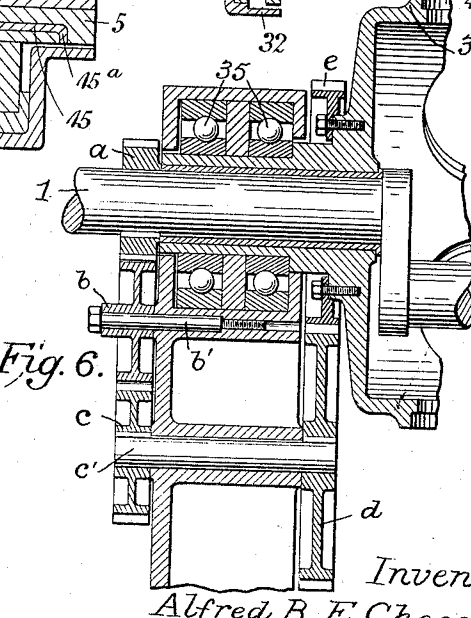


Fig. 6.

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4 SHEETS—SHEET 4.

Fig. 4.

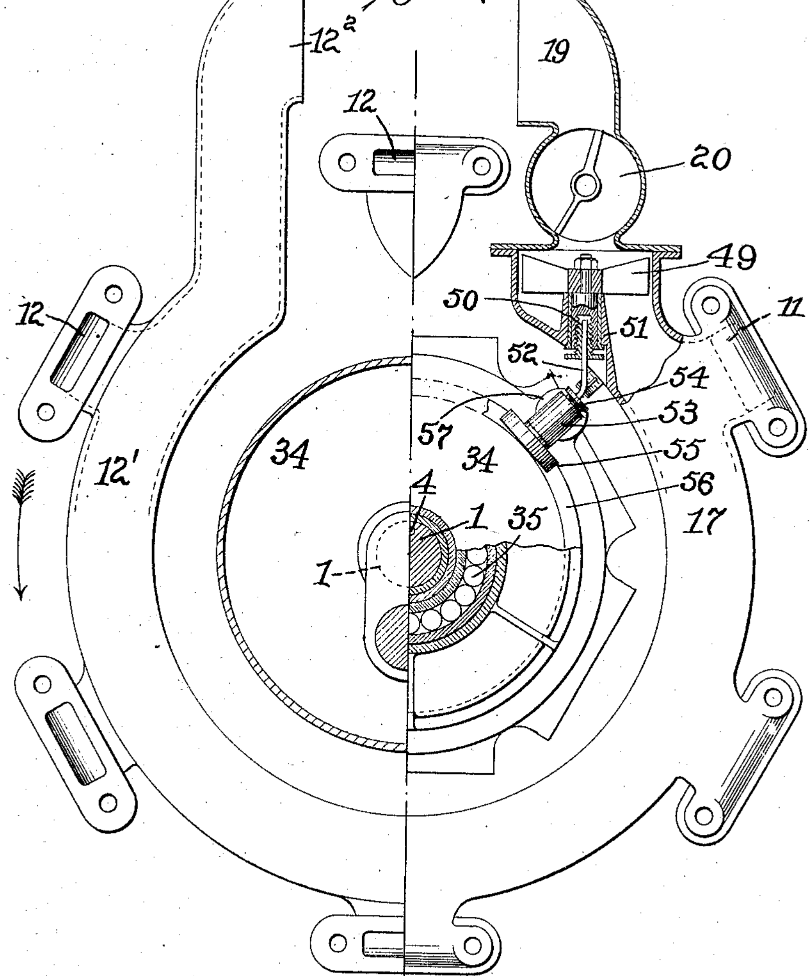
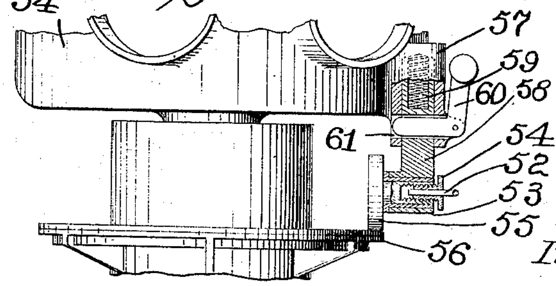


Fig. 5.



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UNITED STATES PATENT OFFICE.

ALFRED B. E. CHEESEMAN, OF LONDON, AND JOSEPH G. FLORENCE, OF WALTHAMSTOW, ENGLAND.

INTERNAL-COMBUSTION ENGINE OF THE REVOLVING-CYLINDER TYPE.

1,019,222. Specification of Letters Patent. Patented Mar. 5, 1912.

Application filed May 27, 1911. Serial No. 629,907.

To all whom it may concern:

Be it known that we, Alfred Bryson East Cheeseman, a subject of the King of Great Britain, residing at 36 Delaware Mansions, Maida Vale, London, and Joseph Gordon Florence, a subject of the King of Great Britain, residing at 125 Coppermill Lane, Walthamstow, Essex, England, have invented certain new and useful Improvements in or Relating to Internal-Combustion Engines of the Revolving-Cylinder Type, of which the following is a specification.

This invention relates to rotary engines of that type in which a number of cylinders revolve, as a unit, around the crank shaft. Hitherto such type of engine, while having considerable advantages in the way of balance and lightness, has suffered from various drawbacks as regards necessity for compressing the charge in the crank chamber, and then passing it into the cylinder; the use of pumps for supplying fuel to the cylinders; mechanical valves; lubrication; valve actuation, and control, and generally in the way of complications due to the rotation of the cylinders.

According to the present invention we do not compress the charge in the crank chamber or use a pump, thereby dispensing with the use of piston valves with their attendant drawbacks, among which may be mentioned the excessive entry of lubricant into the cylinder, the charge according to our invention being introduced to the various cylinders radiating from the crank shaft, through a chamber formed or arranged preferably at the side of the cylinders and rotating with them. Provision is made for the supply of fuel or explosive mixture to the cylinders from this chamber and for the admission of air and petrol or other hydrocarbon to the chamber to form the explosive mixture, this chamber being in communication with the atmosphere in such way that the explosive mixture is supplied automatically to the cylinders under pressure produced by the rotation of the cylinders, a fan being used, or not, to assist in maintaining or obtaining this pressure.

We dispense with mechanical or automatic valves by providing the cylinders with inlet and exhaust ports, which are opened and closed by the pistons in their reciprocation in the cylinders, the engine thus being of the type commonly known as a valveless engine. Thus whatever may be the speed of rotation of the cylinders the ports will be opened and closed in a perfectly regular manner, whereas in engines having spring-controlled valves generally arranged in the heads of the cylinders, the action of centrifugal force comes into play and causes the action of the valves to vary with the speed of rotation of the cylinders.

We provide the supply chamber at the side of the cylinders with a trunk funnel or scoop for the supply of air thereto, and a carbureter may be arranged in the trunk or funnel or in the chamber itself in such manner that as the engine rotates air is forced into the chamber, through or around the carbureter to form, with the fuel introduced through the carbureter, an explosive mixture, which is then supplied to the cylinders as their inlet ports become uncovered by their respective pistons. The cylinders work on the two stroke system with the inlet and exhaust ports arranged substantially opposite one another in the sides of the cylinders, but they need not necessarily be arranged opposite one another.

The cylinders may exhaust straight into the outer air or a silencer or silencers may be provided, for instance by arranging a chamber, similar to the fuel supply chamber, on the exhaust side of the engine, and providing it with an outlet funnel or mouth directed in opposition to the direction of rotation of the engine so that a suction action will be created, tending to assist in the discharge of the exhaust gases, from the cylinders. The inertia of the gases released from any cylinder will have a scavenging effect upon the cylinder that opened to exhaust immediately prior thereto, and the exhaust gases will become a form of jet reaction tending to assist the engine to revolve.

While, in its simpler form, the crank shaft will be stationary, the engine may be constructed so that the shaft rotates in the opposite direction to that of the cylinders.

A small fan or similar feed device may be fitted in the mouth of the air scoop to assist in delivering the air through the trunk and carbureter to the annular chamber, but such fan is not always essential. The mouth of the scoop is set in the direction of rotation so that as the engine revolves, air is forced down the scoop through the trunk around or through the carbureter, into the annular chamber, and the mixture thus formed is delivered through the ports into the cylinders under pressure produced naturally by the method of scooping the air into the trunk as the cylinders revolve. Obviously as the fuel supply chamber rotates with the cylinders the supply of fuel, petrol for instance, must be arranged from a central point, and this can be effected in various ways. For instance petrol may be fed through a bearing of the crank shaft and led through a pipe which may be integral with the crank chamber, to the carbureter fixed in the inlet trunk.

By the means above described, the ordinary type of inlet and exhaust valves is dispensed with and the engine is worked on a 2-stroke cycle in place of the "Otto" or 4-stroke cycle.

Ignition is effected by leads integral with or connected to the revolving parts and carried through the outer casing of the bearing to or near the periphery thereof, where a distributer wipe connected to a magneto or other electrical source is pressed by a spring or other means against the leads, or other form of distributer may be arranged.

As it is desirable that there should be control of the carbureter, such control may be effected by a flexible wire passing through the casing of the bearing to a sleeve which can slide upon a spigot extension of the crank shaft bearing. The sleeve and flexible wire rotate with the engine. This sleeve may be actuated by a suitable lever attachment. The throttle may be kept open by a spring or other means, and the flexible wire used only for closing the valve or vice versa. The carbureter could also be controlled by means of an adjustable lug or ring on a stationary part, acting on a lever, projection or other device connected to the carbureter, so that in accordance with the position of the adjustable ring or equivalent, the opening of the carbureter will be varied and controlled. In the case of a float feed carbureter being used, or where it is undesirable to place the carbureter on or in the rotary part of the apparatus, we may arrange the carbureter on a stationary part, and lead the petrol supply to the annular chamber. The petrol may be led to the spigot extension of the crank-shaft bearing by a fixed nozzle entering the hollow end through a gland and packed stuffing box so as to prevent leakage. The cylinders may be connected up to a single or multiple crank shaft and may be of any desired number, and caused to act consecutively. The whole engine may revolve on two main bearings with the cylinders and pistons between them, the main bearings being supported upon ball races, and end thrust taken up by ball races. When the engine is used for purposes of a flying machine where screw propellers or tractors are necessary, the propeller or tractor blades may be fitted to the cylinders or to the cylinder heads.

We will now describe a practical form of the invention, reference being had to the accompanying drawings, in which like reference characters refer to like parts.

Figure 1 is a sectional elevation of a six-cylinder engine according to the present invention, and Fig. 2 is a side view, partly in section, and Fig. 3 is a detail view. Fig. 4 shows, in two half views, side elevations, partly in section, of parts of the annular chambers forming the mixing chamber and exhaust chamber respectively, the right hand half of this figure illustrating the fan and means for driving it. Fig. 5 shows a detail view of the automatic means for controlling the speed of the fan. Fig. 6 is a sectional detail illustrating means for causing the crank shaft and casing to rotate in opposite directions.

The crank shaft 1 of the engine is stationary, its squared end being mounted in a bearing or dog 8 secured by bolts 9 to a fixed part 16 of the engine frame. A crank casing 34 carrying six cylinders 10 arranged radially about the crank shaft 1 is mounted so as to freely revolve around the crank shaft; suitable main ball bearings 35 and thrust ball bearings 36 being provided on each side of the casing. The piston 13 of each cylinder is connected by a rod to the crank, one of the connecting rods 2 being mounted directly on a bushing 3 on the crank pin and the other five connecting rods 6 being mounted on bushings 7 on gudgeon pins 15 mounted in the forked end of the connecting rod 2, in well known manner.

Now in order to avoid the use of ordinary mechanically operated inlet and exhaust valves for the cylinders, we run the engine on the two stroke system, forming inlet and exhaust openings 11 and 12, in the cylinders which are covered and uncovered as the pistons reciprocate in the cylinders. As is usual in this class of engine, a deflector 14 is formed on the piston to prevent the incoming charge from passing straight across the cylinder to the exhaust which is open at approximately the same time.

In order to provide for the introduction of the charge to the cylinders as they rotate, we provide on one side of the cylinders a closed casing, here shown in the form of a flattened tubular ring 17. This ring may, however, be of circular cross section, or the chamber may be formed by a casing, bolted to the sides of the cylinders, of such construction as to provide a substantially annular passage or conduit, communicating with the openings 11 in the cylinders. In Fig. 2 this annular pipe or conduit 17 is shown as secured to the cylinders by means of studs and nuts 18. This annular chamber is provided with an air inlet funnel or scoop 19 with its mouth in the direction of the rotation of the cylinders, so that as the cylinders rotate air is forced down the funnel into the chamber. At about the point where the funnel merges into the annular chamber, is arranged a carbureter or mixing device 20 having a throttle valve 23 and a petrol jet or passage 22, the valve controlling the inlet and outlet of the carbureter. The petrol discharges into the center of the throttle valve and passes thence outwardly, the throttle being in the form of a part cylinder, the turning of which regulates both the supply of fuel and air. However no special form of supply and throttle device is claimed in this application, as any suitable form or valve device can be used. Petrol is supplied to the passage 22 by means of a supply pipe 21, which is brought down and enters the rear end bearing 5 (Fig. 3) of the crank shaft. Here the pipe communicates with a tubular passage 4 formed in the bearing 5, and in its extension 5^a the petrol supply passage 4^a here being in the axial center of the shaft. Leading into the center of the extension 5^a is the fixed petrol supply pipe 47, a suitable stuffing box 48 being provided to form a tight joint between the rotating part 5^a and the stationary part 47. It will thus be seen that petrol can be supplied, from any suitable source of supply, through the inlet 47, and thence through the passages 4^a, 5^a and tube 21 to the jet in the chamber 17.

It may be mentioned here that although the method described of supplying fuel to the cylinders is a satisfactory one, it is obvious that it is not the only way in which this could be done. For instance, a pipe might proceed directly from the jet to a box or scoop mounted on the axial extension of the crank shaft bearing, the fixed supply pipe 47 communicating with this box or scoop. Further, instead of supplying petrol, other fuel or gaseous substance or mixture may be provided and supplied to the annular chamber, in which case a carbureter inside the funnel or chamber would not be necessary, but a rich mixture would be used and the air supply through the funnel would be so controlled, as by a valve, operated in a similar manner to the throttle valve of the carbureter, that the desired strength of mixture could be obtained and controlled. This rich mixture or vapor would require so much air that the air throttle would be open to such an extent as to allow the pressure of air in the funnel to act in the manner described as it is essential that the pressure in the annular chamber must be in excess of that in the cylinder when the admission ports open.

It is desirable to be able to control or regulate the opening of the throttle valve 23 from the outside, and for this purpose we provide the valve with a pulley 24 to which a control wire 26 is secured, the valve being provided with a suitable spring, which acts against the pull of the control wire. This wire is brought down toward the crank shaft bearing and passes parallel to the crank shaft to a sleeve 30 mounted so as to slide on the bearing extension 5^a. This sleeve can turn in a ball thrust cage 32 pivotally mounted in or on a central lever 27, hinged at 31 to a fixed part 38 of the frame, and provided with a clamping nut 29 for securing the lever in any adjusted position along a bar or tube 28. By moving the lever 27, the wire 26 can be moved backward or forward as desired, the spring on the throttle valve tending to draw the cage 32 to the left.

When the engine is running at a high speed, the air is driven into the funnel and annular chamber at a sufficiently high pressure, but when running slowly it is advisable or necessary to supplement this pressure, and we therefore provide in the funnel or in the chamber a fan positively driven from the outside. A method of effecting this is illustrated in Fig. 4. Between the annular chamber 17 and its funnel 19 we insert the carbureter and below it a fan 49, the diameter of which is approximately equal to the internal diameter of the portion of the chamber 17 in which it works. The fan is secured to a shaft portion or spindle 50 mounted and rotatable in a bearing 51 formed or provided in the wall of the chamber 17. To this shaft is secured a flexible wire or cat-gut connection 52, attached at its other end to a rotatable spindle 54 mounted in a tubular bearing 53 on the crank casing which rotates with the engines. The end of this shaft 54 carries a friction roller 55 which engages a trackway 56 on a stationary part of the engine. The result will be that as the engines, and with them the annular chamber 17, rotate the friction roller 55 will run on the trackway 56 and thus drive the fan. The size of the pulley is preferably such that it rotates about 5 times to each completed rotation of the engine.

At slow speed the fan will be constantly driven, but at high speed a governor device comes into operation to lessen the speed of the fan or even to cut it out altogether. This device is shown in Fig. 5. The shaft of the friction roller 55 rotates in a bearing sleeve on the end of a rod or bracket 58 longitudinally movable in a bearing 57 in one with or secured to the casing 34 carrying the cylinders. This rod 58 is pressed outward by a spring 59 so as to cause the roller 55 to press against its track 56. Mounted on the bearing sleeve 57 is a bell-crank lever 60 one arm of which lies in a slot 61 formed in the sleeve 57 and rod 58, while its other end is weighted, the device acting as a centrifugal governor. Thus at slow or normal speed the roller 55 will remain in engagement with the trackway 56 and rotate continuously and through the flexible connection 52 cause the fan to rotate. On the engine revolving at a high speed the centrifugal governor 60 will come into action and temporarily withdraw the roller from its trackway producing thereby a slower rotation or even absolute stoppage of the fan. The fan may either be in front of or behind the mixing chamber.

The products of combustion pass out from the cylinders through the exhaust openings 12 into an annular chamber 12′ which may be similar to the chamber 17, the chamber 12′ having its outlet opening 12 (Fig. 4) in the direction opposite to that of the rotation of the cylinders, so that a suction action is created, when the engine is running, which assists in the evacuation of the cylinders. This chamber may be arranged to act as a silencer, but, if desired, each outlet may be provided with a separate chamber.

It now remains to describe how the charge is fired in each cylinder. Each cylinder is provided with a sparking plug 18 (Fig. 1) to which a lead 16 is connected, the other end of this lead having a plug which is inserted in a metallic socket member 25 in the rotating part surrounding the crank shaft. Each socket member is in electrical contact or connection with an insulated contact wire or strip 45 in the hub or outer casing of the bearing parallel with the shaft and terminating in an exposed contact surface 45^a. There are thus six contact surfaces at equal distances apart around the shaft. A stationary distributer wiper 44 pressed down by a spring is adapted to come into contact successively with these contact surfaces 45^a as the engine revolves. The wiper 44 is in electrical connection with the high tension wire from the magneto 39 suitably mounted on the framing of the engine. The magneto is driven by a gear wheel 42 keyed on its shaft, and engaging a corresponding gear wheel 41 mounted on the rotating tubular bearing part of the engine casing, and thus the magneto is driven at a speed corresponding to that of the revolving cylinders.

We have stated that instead of the crank shaft being stationary, it may revolve in the opposite direction to that of the engine, in which case we interpose gearing between the crank shaft and the rotating casing, so that the two rotate in opposite directions in fixed relationship. A method of effecting this is shown in Fig. 6. The crank shaft 1 has keyed upon it a toothed wheel *a* gearing with and driving an idle wheel *b* mounted on the shaft *b′* carried by the casing. This intermediate wheel *b* drives a toothed wheel *c* keyed on a shaft *c′* which has also keyed on it a second toothed wheel *d* which meshes with and drives a toothed wheel *e* secured to the rotatory casing 34 carrying the cylinders. It will be seen that by the interposition of the idle wheel *b* the gear wheel *a* and shaft 1 rotate in the opposite direction to the wheel *e* and casing 34.

If the engine is used on an aeroplane, the propellers or tractors may be bolted or otherwise secured to the cylinders as indicated at 49 in Fig. 2. In this case or in other cases the air supply funnel may be arranged at the side of the annular chamber instead of in line with it.

What we claim and desire to secure by Letters Patent is:—

1. A multi-cylinder rotary valveless two-stroke internal combustion engine, comprising a fixed crank shaft, a series of radial cylinders adapted to rotate around said crank shaft, pistons in said cylinders acting on the crank shaft, a fuel supply chamber common to and communicating with said cylinders, means for introducing fuel to said chamber, the said chamber having an air inlet to the atmosphere opening in the direction of rotation of the cylinders for automatically supplying air to the fuel under pressure produced by the speed of rotation of the engine, substantially as described.

2. A multi-cylinder rotary valveless two-stroke internal combustion engine comprising a fixed crank shaft, a radial series of cylinders adapted to rotate around said crank shaft, pistons in said cylinders acting on said crank shaft, means for supplying explosive mixture automatically to the cylinders under pressure produced by the rotation of the cylinders, and a fan for increasing the pressure produced by the rotation of the cylinders.

3. A multi-cylinder rotary valveless two-stroke internal combustion engine comprising a fixed crank shaft, a radial series of cylinders rotating around said shaft and having pistons acting on said crank shaft, a common supply chamber for explosive fluid revolving with and communicating with each of said cylinders, said chamber having an intake opening to the atmosphere facing in the direction of rotation of the engine for the purpose of producing pressure in said chamber, substantially as set forth.

4. A multi-cylinder rotary valveless two-stroke internal combustion engine comprising a fixed crank shaft, a radial series of cylinders adapted to rotate around said crank shaft and having pistons acting on said crank shaft, a common supply chamber for explosive fluid revolving with and communicating with each of said cylinders, said chamber having an intake opening to the atmosphere facing in the direction of rotation of the engine for the purpose of producing pressure in said chamber, and a fan for increasing the pressure produced by the rotation of the cylinders, substantially as set forth.

5. A multi-cylinder rotary valveless two-

stroke internal combustion engine comprising a fixed crank shaft, a radial series of cylinders adapted to rotate around said crank shaft and having pistons acting on said crank shaft, an annular lateral supply chamber for explosive fluid revolving with and communicating with said cylinders, said chamber having an opening to the atmosphere facing in the direction of rotation of the engine for the purpose of producing pressure in said chamber, substantially as set forth.

6. A multi-cylinder rotary valveless two-stroke internal combustion engine comprising a fixed crank shaft, a radial series of cylinders adapted to rotate about said crank shaft, pistons in said cylinders acting on said crank shaft, ports in said cylinders adapted to be covered and uncovered by the pistons in their reciprocations, an annular lateral supply chamber for explosive fluid revolving with and communicating with said cylinders and having an intake opening to the atmosphere facing in the direction of rotation of the engine for the purpose of producing pressure in said chamber, and a fan for increasing the pressure produced by the rotation of the cylinders, substantially as set forth.

7. A multi-cylinder rotary valveless two-stroke internal combustion engine comprising a fixed crank shaft, a radial series of cylinders adapted to rotate about said crank shaft and having pistons acting on said crank shaft, a common supply chamber for explosive fluid revolving with and communicating with each of said cylinders, a carbureter in said chamber, said chamber having an intake opening to the atmosphere facing in the direction of rotation of the engine for the purpose of producing pressure in said chamber, substantially as set forth.

8. A multi-cylinder rotary valveless two-stroke internal combustion engine comprising a fixed crank shaft, a radial series of cylinders adapted to rotate about said crank shaft and having pistons acting on said crank shaft, a supply chamber for explosive fluid revolving with and communicating with said cylinders, a carbureter in said chamber, said chamber having an intake opening to the atmosphere facing in the direction of rotation of the engine for the purpose of producing pressure in said chamber, and a fan for increasing the pressure produced by the rotation of the cylinder, substantially as set forth.

9. A multi-cylinder rotary valveless two-stroke internal combustion engine comprising a fixed crank shaft, a radial series of cylinders adapted to rotate about said crank shaft and having pistons acting on said crank shaft, an annular lateral supply chamber for explosive fluid revolving with and communicating with said cylinders, a carbureter in said chamber, said chamber having an intake opening to the atmosphere facing in the direction of rotation of the engine for the purpose of producing pressure in said chamber, substantially as set forth.

10. A multi-cylinder rotary valveless two-stroke internal combustion engine comprising a fixed crank shaft, a radial series of cylinders adapted to rotate about said crank shaft and having pistons acting on said crank shaft, a supply chamber for explosive fluid revolving with and communicating with said cylinders, said chamber having an intake opening to the atmosphere facing in the direction of rotation of the engine for the purpose of producing pressure in said chamber, and a chamber on the exhaust side of said cylinders and communicating with the exhaust ports of said cylinders, said chamber having an outlet opening facing in a direction opposite to the direction of rotation of the engine, substantially as set forth.

11. A multi-cylinder rotary valveless two-stroke internal combustion engine comprising a fixed crank shaft, a radial series of cylinders adapted to rotate about said crank shaft and having pistons acting on said crank shaft, an annular lateral supply chamber for explosive fluid revolving with and communicating with said cylinders, a carbureter in said chamber, said chamber having an outwardly extending intake pipe provided with an open end facing in the direction of rotation of the engine for the purpose of producing pressure in said chamber, and a chamber on the exhaust side of said cylinders and communicating with the exhaust ports of said cylinders and an outlet in said chamber opening in a direction opposite to the direction of rotation of the engine, substantially as set forth.

12. A multi-cylinder rotary valveless two-stroke internal combustion engine comprising a fixed crank shaft, a radial series of cylinders adapted to rotate about said crank shaft and having pistons acting on said crank shaft, a supply chamber for explosive fluid revolving with and communicating with said cylinders, a carbureter in said chamber, said chamber having an intake opening to the atmosphere facing in the direction of rotation of the engine for the purpose of producing pressure in said chamber, a fan for increasing the pressure produced by the rotation of the cylinder, and means for controlling the carbureter valve, substantially as set forth.

13. A multi-cylinder rotary valveless two-stroke internal combustion engine comprising a fixed crank shaft, a radial series of cylinders adapted to rotate about said crank shaft and having pistons acting on said crank shaft, an annular lateral supply

chamber for explosive fluid revolving with and communicating with said cylinders, a carbureter in said chamber, said chamber having an offset intake opening to the atmosphere in the direction of rotation of the engine for the purpose of producing pressure in said chamber, and means for controlling the carbureter valve, substantially as set forth.

14. A multi-cylinder rotary valveless two-stroke internal combustion engine comprising a fixed crank shaft, a radial series of cylinders adapted to rotate about said crank shaft and having pistons acting on said crank shaft, a supply chamber for explosive fluid revolving with and communicating with said cylinders, a carbureter in said chamber, said chamber having an intake opening to the atmosphere in the direction of rotation of the engine for the purpose of producing pressure in said chamber, and means for supplying the fuel charge for the carbureter through the crank shaft bearings, substantially as set forth.

15. A multi-cylinder rotary valveless two-stroke internal combustion engine comprising a fixed crank shaft, a radial series of cylinders adapted to rotate about said crank shaft and having pistons acting on said crank shaft, a supply chamber for explosive fluid revolving with and communicating with said cylinders, a carbureter in said chamber, said chamber having an intake opening to the atmosphere in the direction of rotation of the engine for the purpose of producing pressure in said chamber, a fan in said chamber for increasing the pressure produced by the rotation of the cylinder, and means for supplying the fuel charge for the carbureter through the crank shaft bearings, substantially as set forth.

16. A multi-cylinder rotary valveless two-stroke internal combustion engine comprising a fixed crank shaft, a radial series of cylinders adapted to rotate about said crank shaft and having pistons acting on said crank shaft, an annular supply chamber for explosive fluid revolving with and communicating with said cylinders having an offset portion with an intake opening facing in the direction of rotation of the engine, a carbureter in said offset portion, and means for supplying the fuel charge for the carbureter through the crank shaft bearings, substantially as set forth.

17. A multi-cylinder rotary valveless two-stroke internal combustion engine comprising a fixed crank shaft, a radial series of cylinders adapted to rotate about said crank shaft and having pistons acting on said crank shaft, an annular lateral supply chamber for explosive fluid revolving with and communicating with said cylinders, said supply chamber having an offset intake portion opening to the atmosphere in the direction of rotation of the engine, a carbureter in said offset portion, a fan in said chamber in proximity to the carbureter, and means for supplying the fuel charge for the carbureter through the crank shaft bearings, substantially as set forth.

18. A multi-cylinder rotary valveless two-stroke internal combustion engine comprising a fixed crank shaft, a radial series of cylinders adapted to rotate about said crank shaft and having pistons acting on said crank shaft, an annular supply chamber for explosive fluid revolving with and communicating with said cylinders, said chamber having an offset portion opening to the atmosphere in the direction of rotation of the engine for the purpose of producing pressure in said chamber, an annular chamber on the exhaust side of said cylinders and communicating with the exhaust ports of said cylinders, said chamber having an offset portion provided with a discharge opening in a direction opposite to the direction of rotation of the engine, substantially as set forth.

In testimony whereof we have affixed our signatures in the presence of two witnesses.

ALFRED B. E. CHEESEMAN.
JOSEPH G. FLORENCE.

Witnesses:
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WILLIAM S. COLLINS.