No. 868,202. PATENTED OCT. 15, 1907.

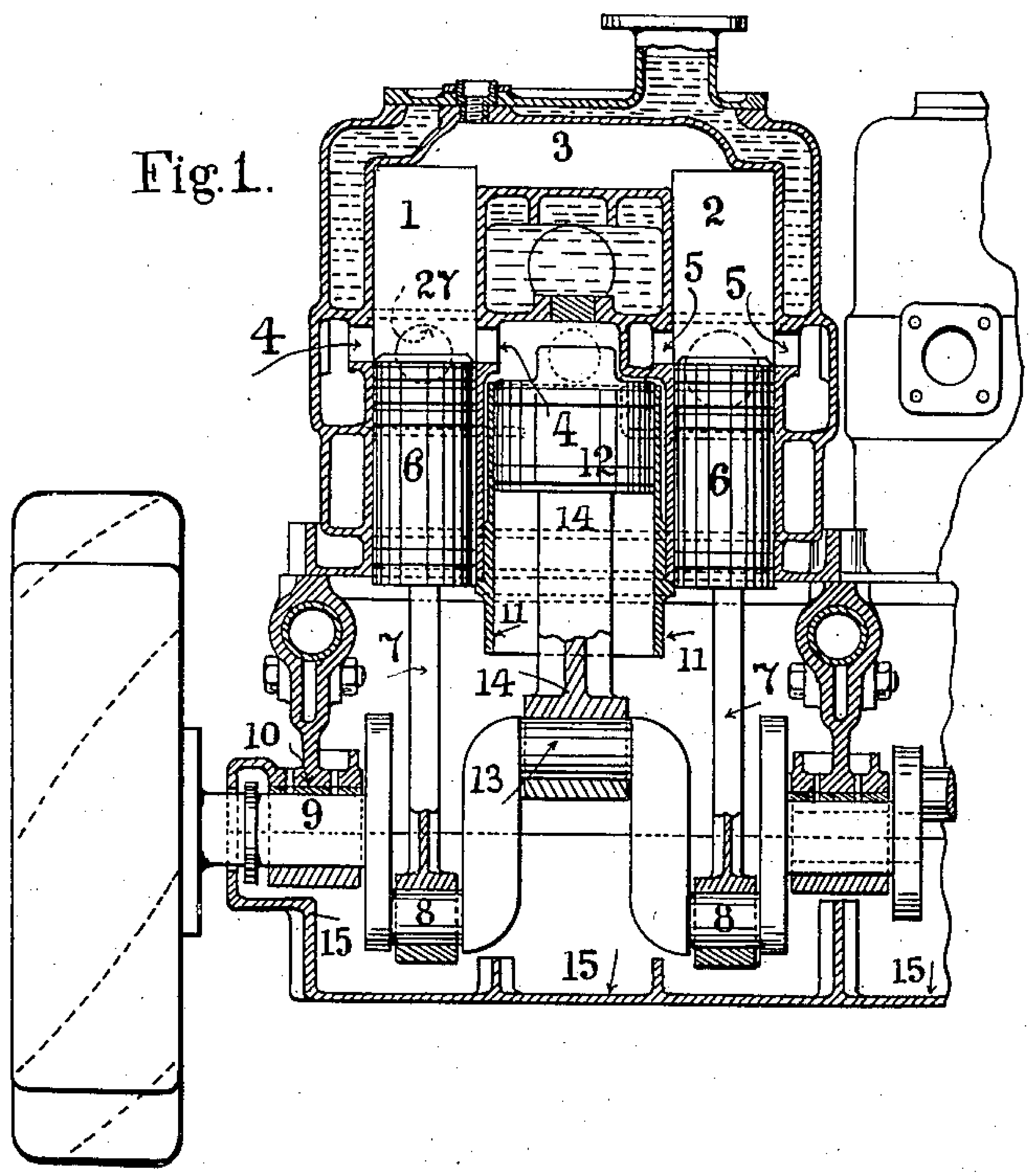
N. MACBETH.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED MAR. 6, 1907.

9 SHEETS—SHEET 1.

Fig.1.



WITNESSES.

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By his Attorney

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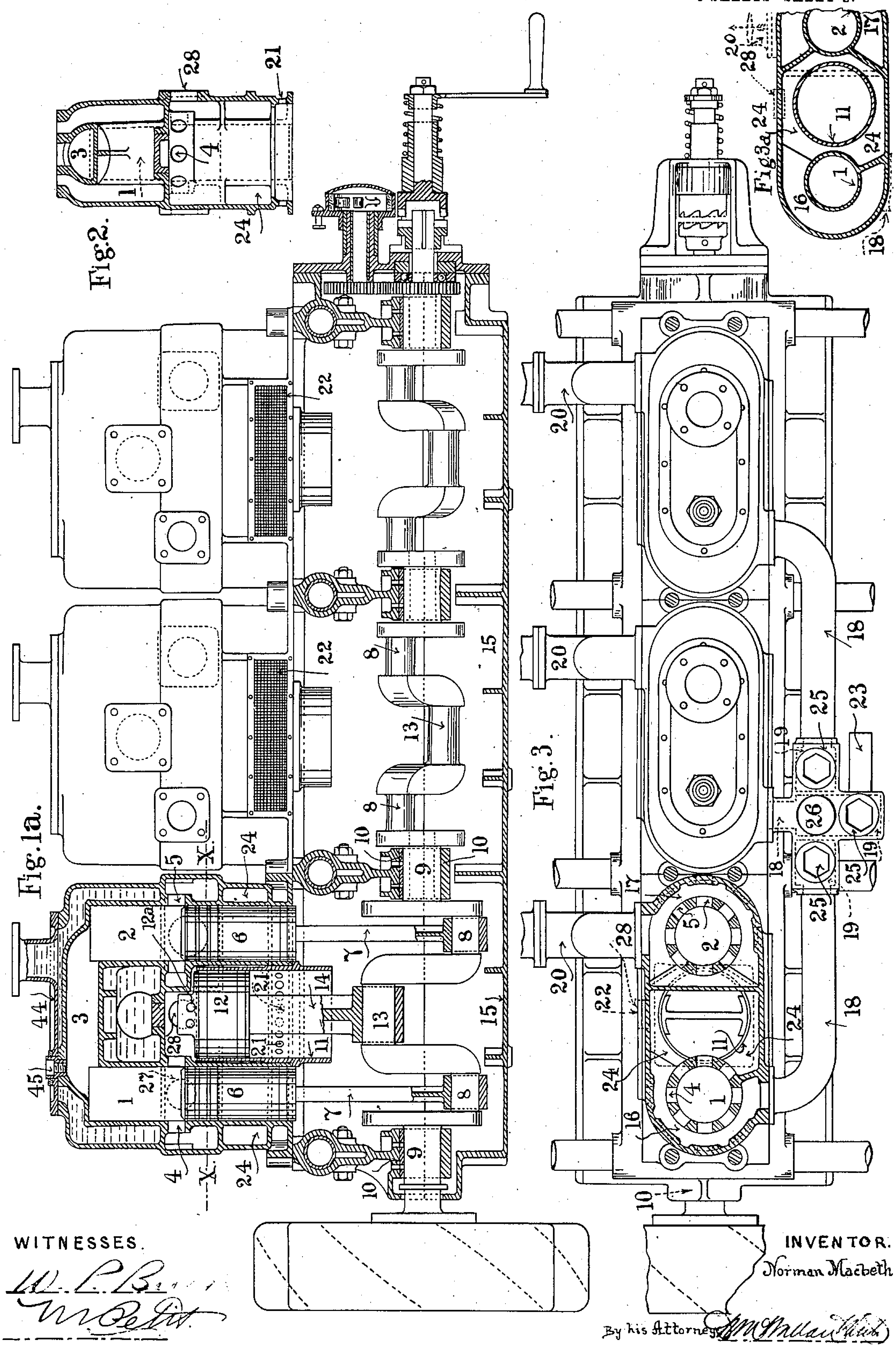
9 SHEETS—SHEET 2.



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9 SHEETS—SHEET 3.

Fig. 4.

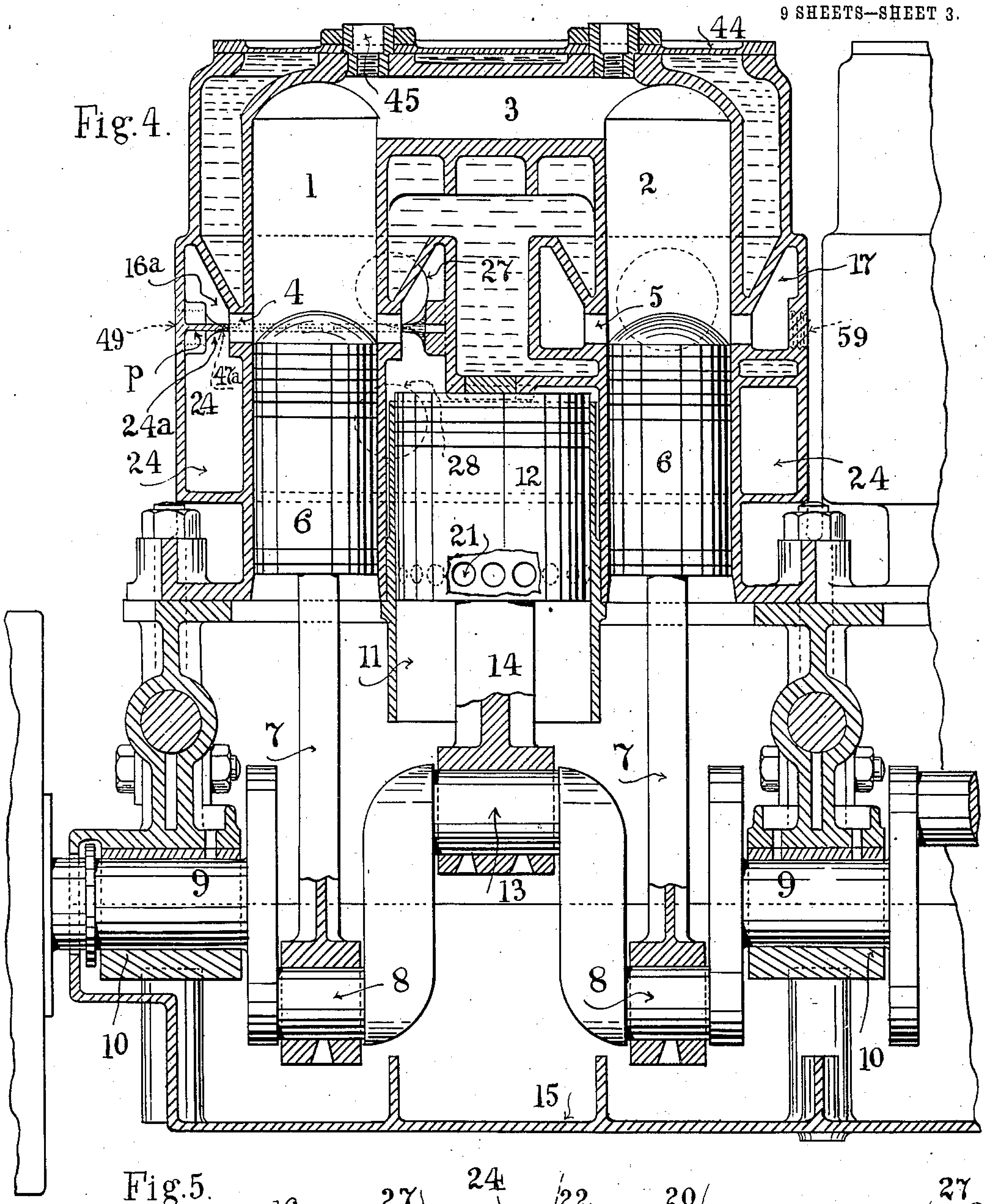
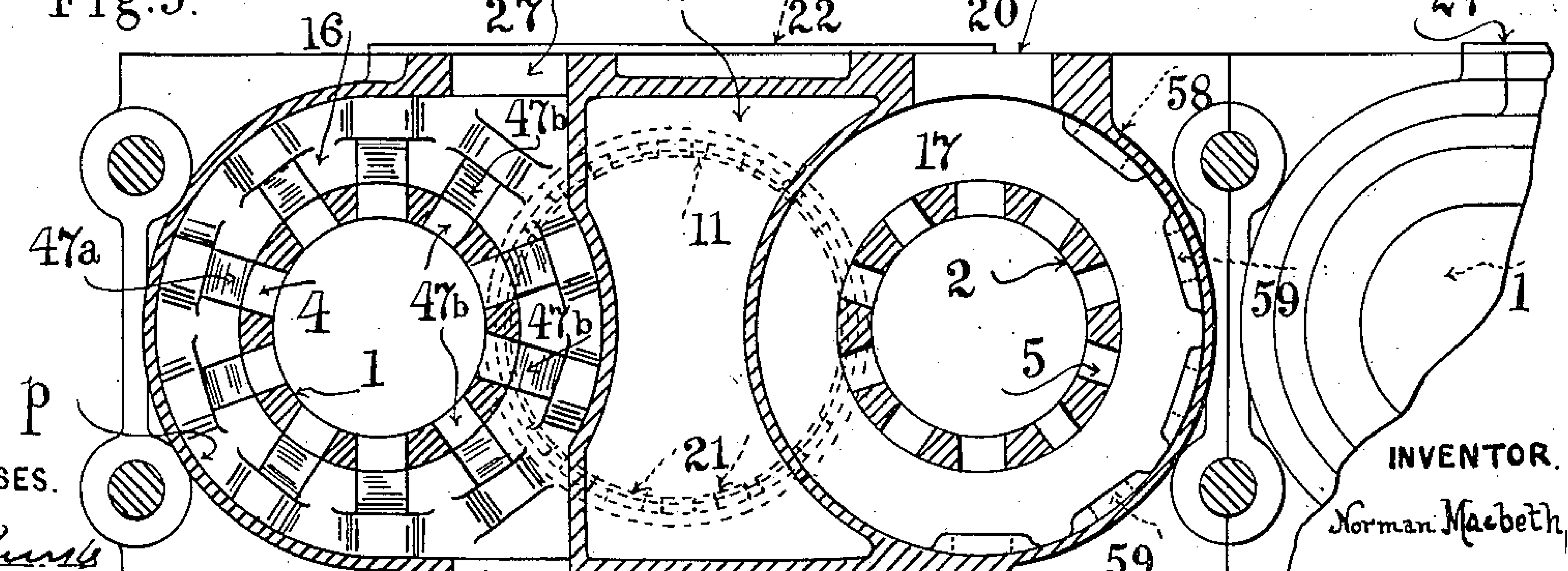


Fig. 5.



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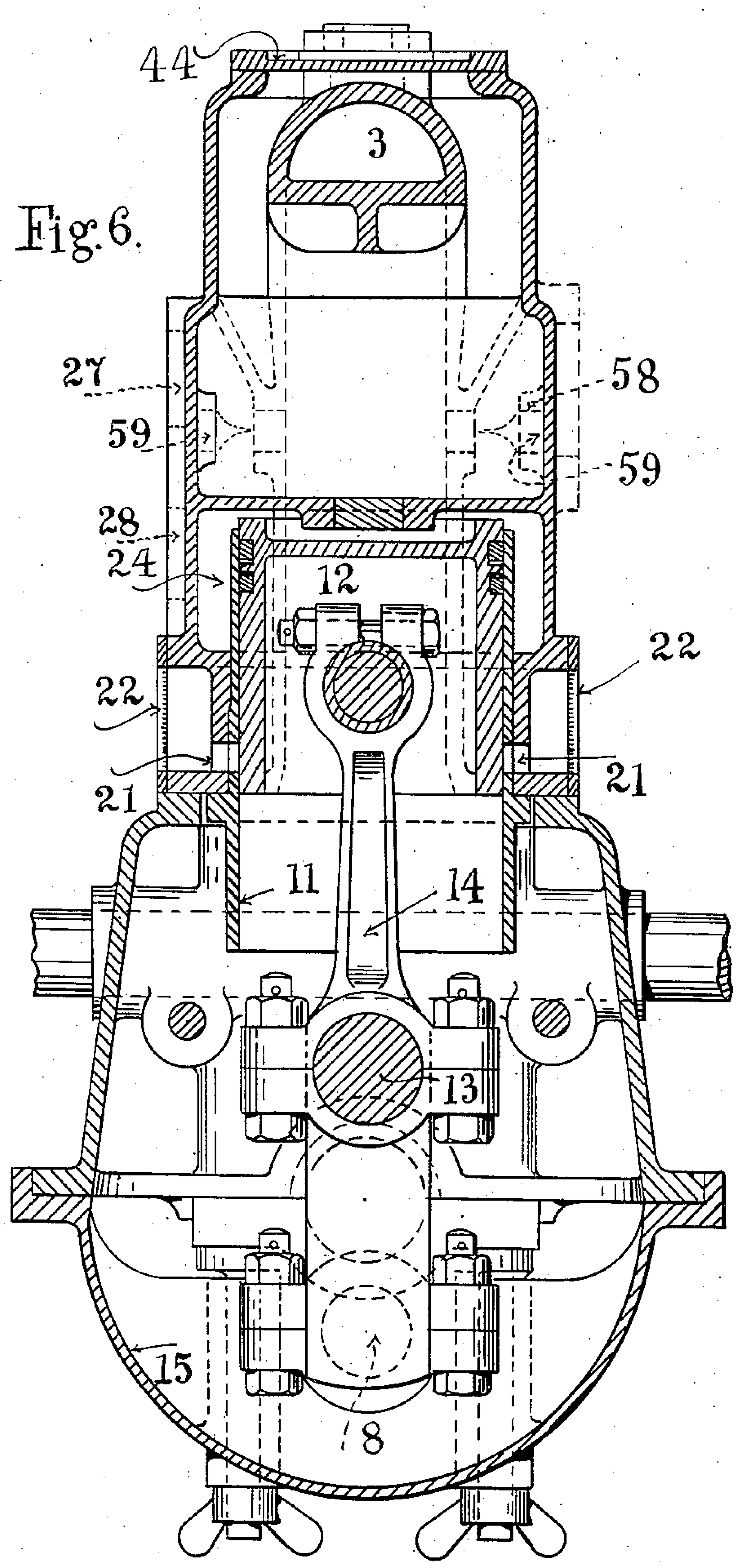
9 SHEETS—SHEET 4.

Fig. 6.



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No. 868,202. PATENTED OCT. 15, 1907.

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9 SHEETS—SHEET 5.

Fig. 7.

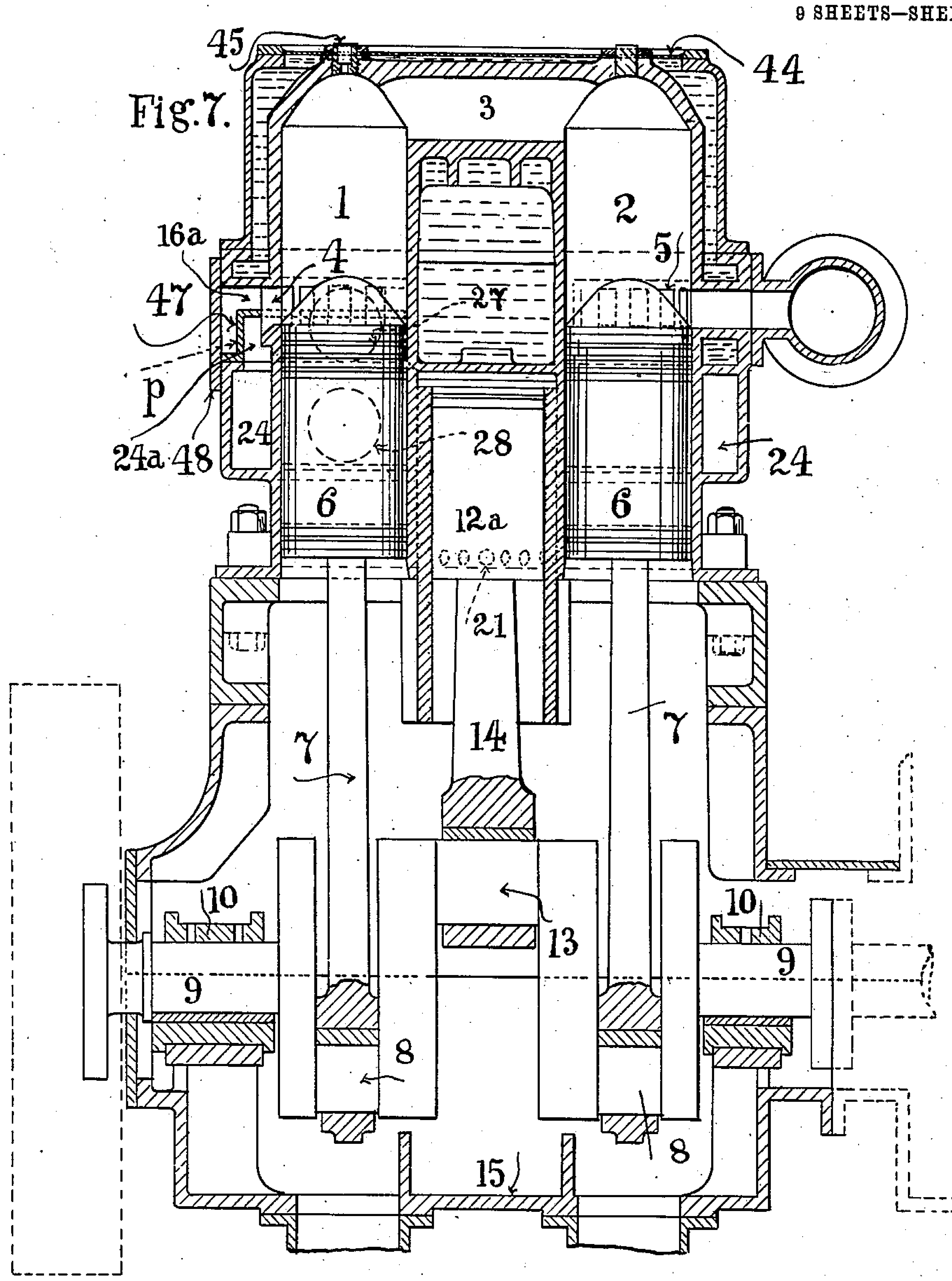
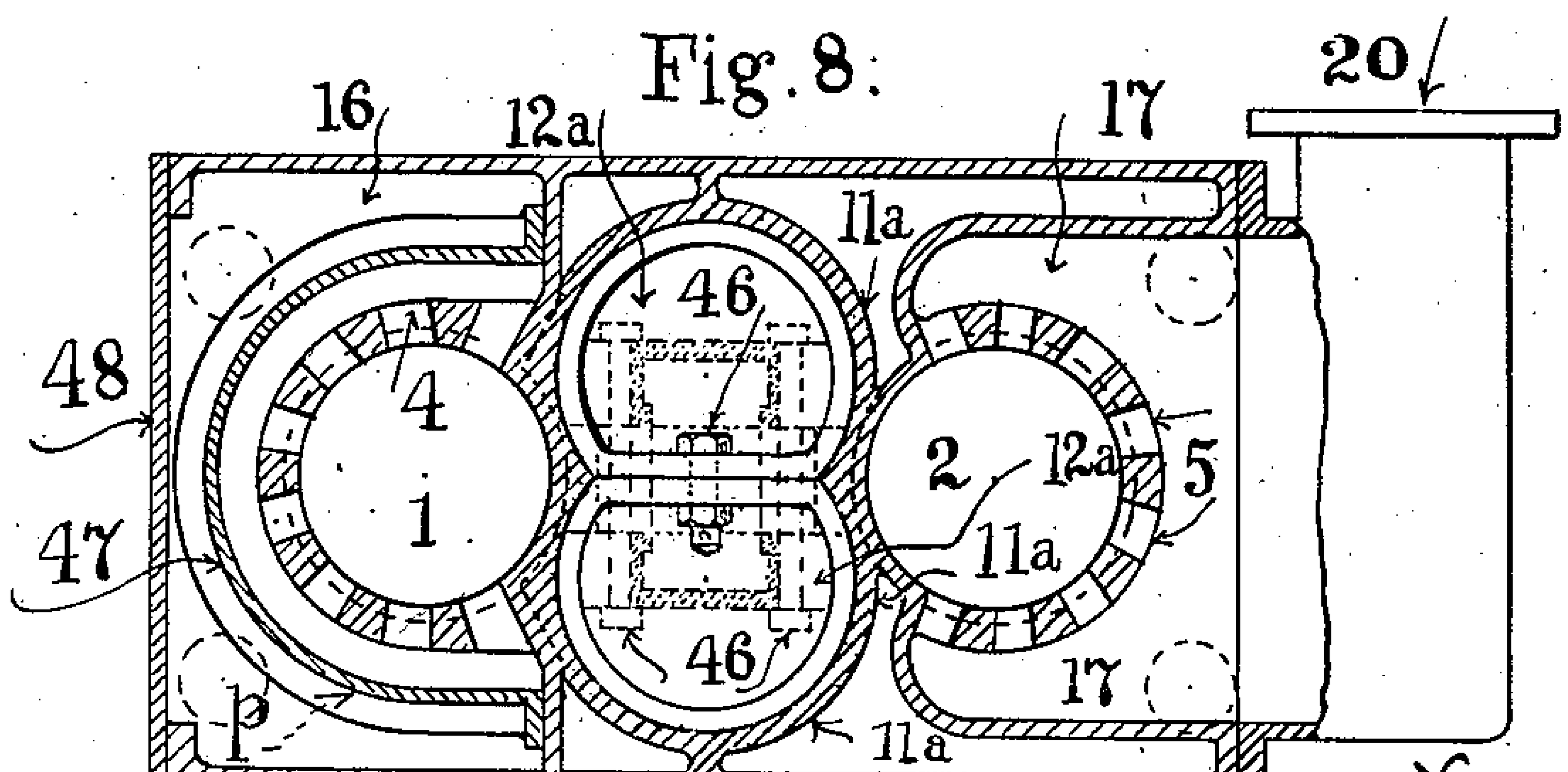


Fig. 8:



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INTERNAL COMBUSTION ENGINE.

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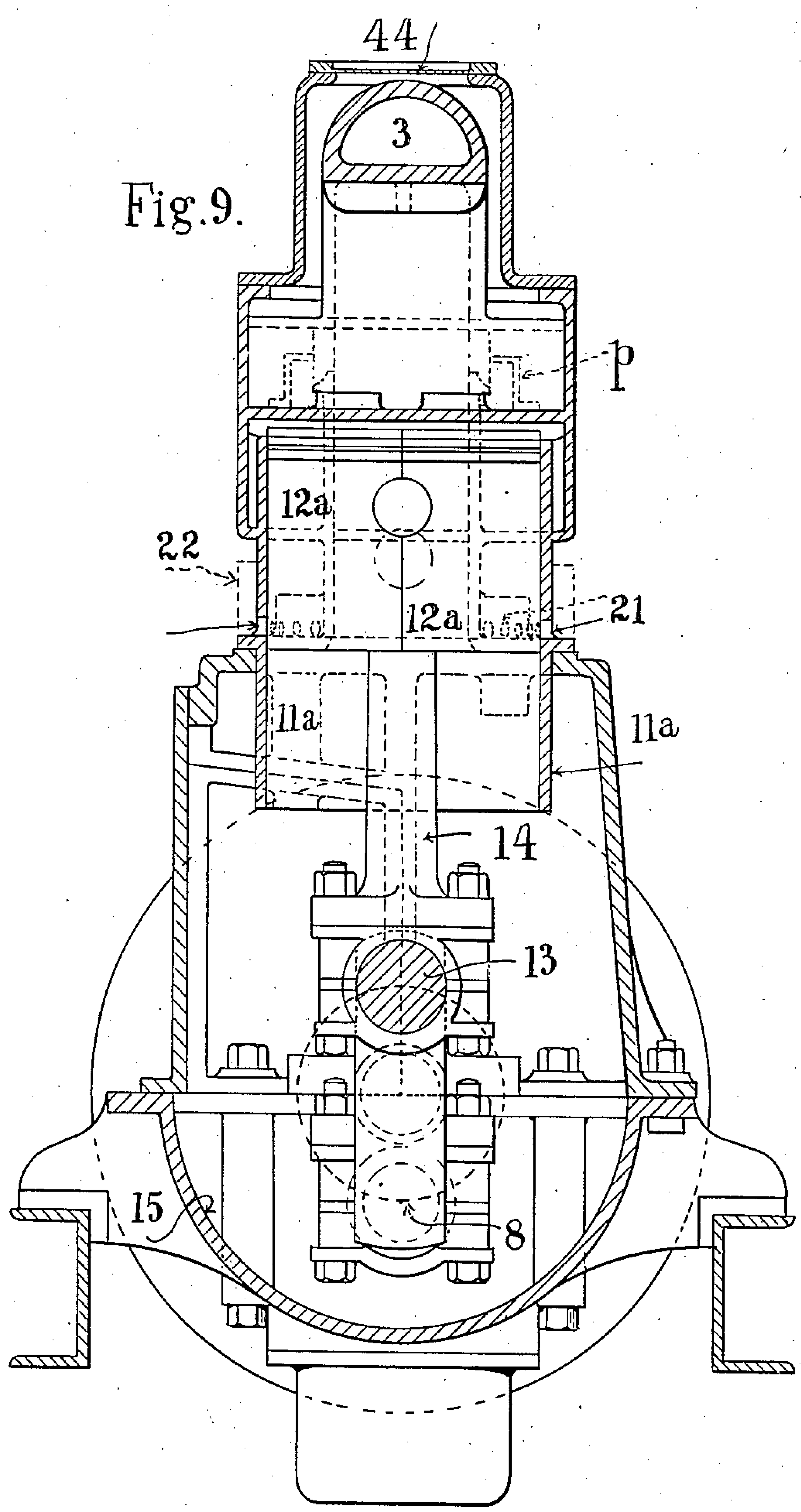
9 SHEETS—SHEET 6.

Fig. 9.



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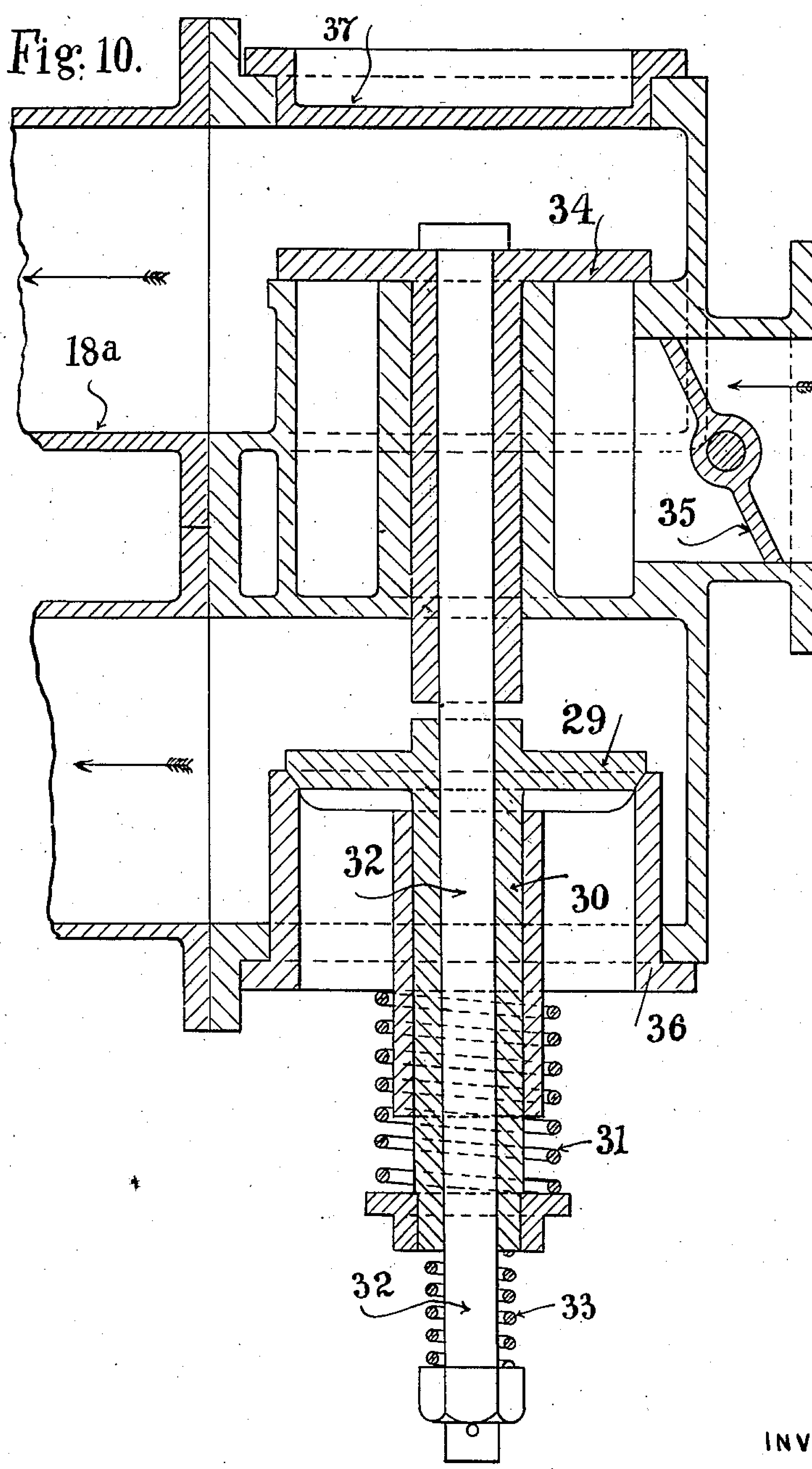
INTERNAL COMBUSTION ENGINE.

APPLICATION FILED MAR. 6, 1907.

9 SHEETS—SHEET 7.

Fig: 10.



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N. MACBETH.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED MAR. 6, 1907.

9 SHEETS—SHEET 8.

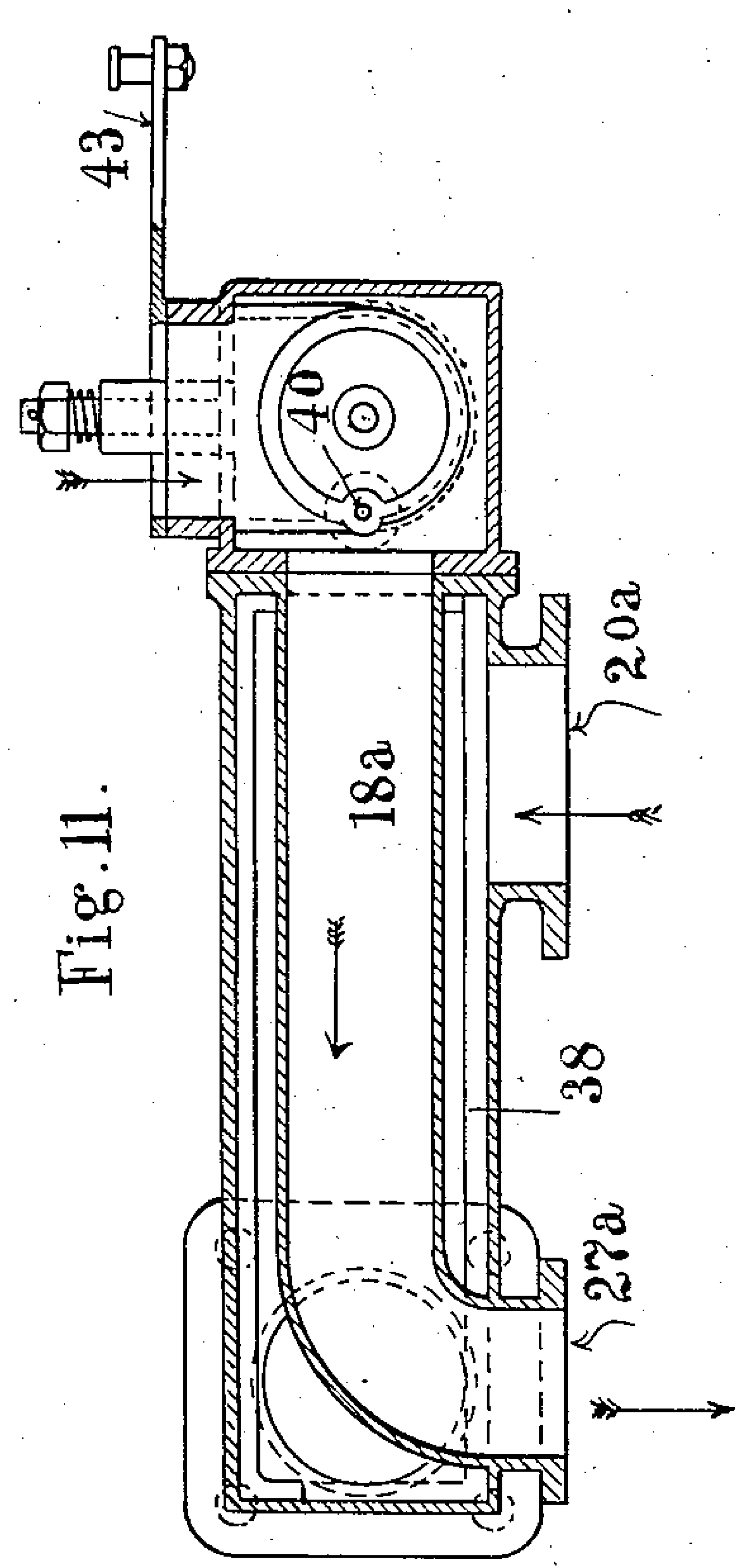

Fig. 11.

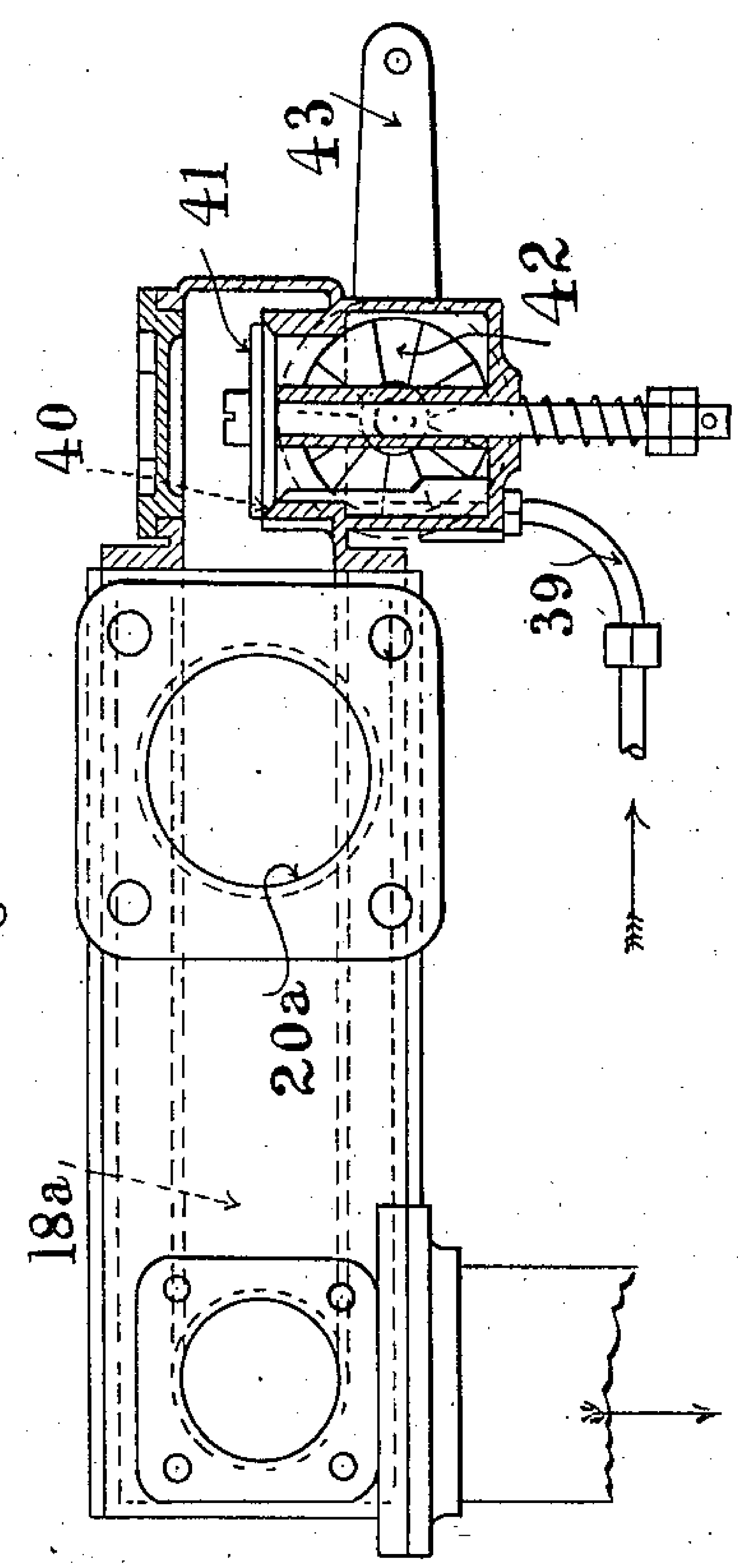

Fig. 12.

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9 SHEETS—SHEET 9.

Fig. 14.

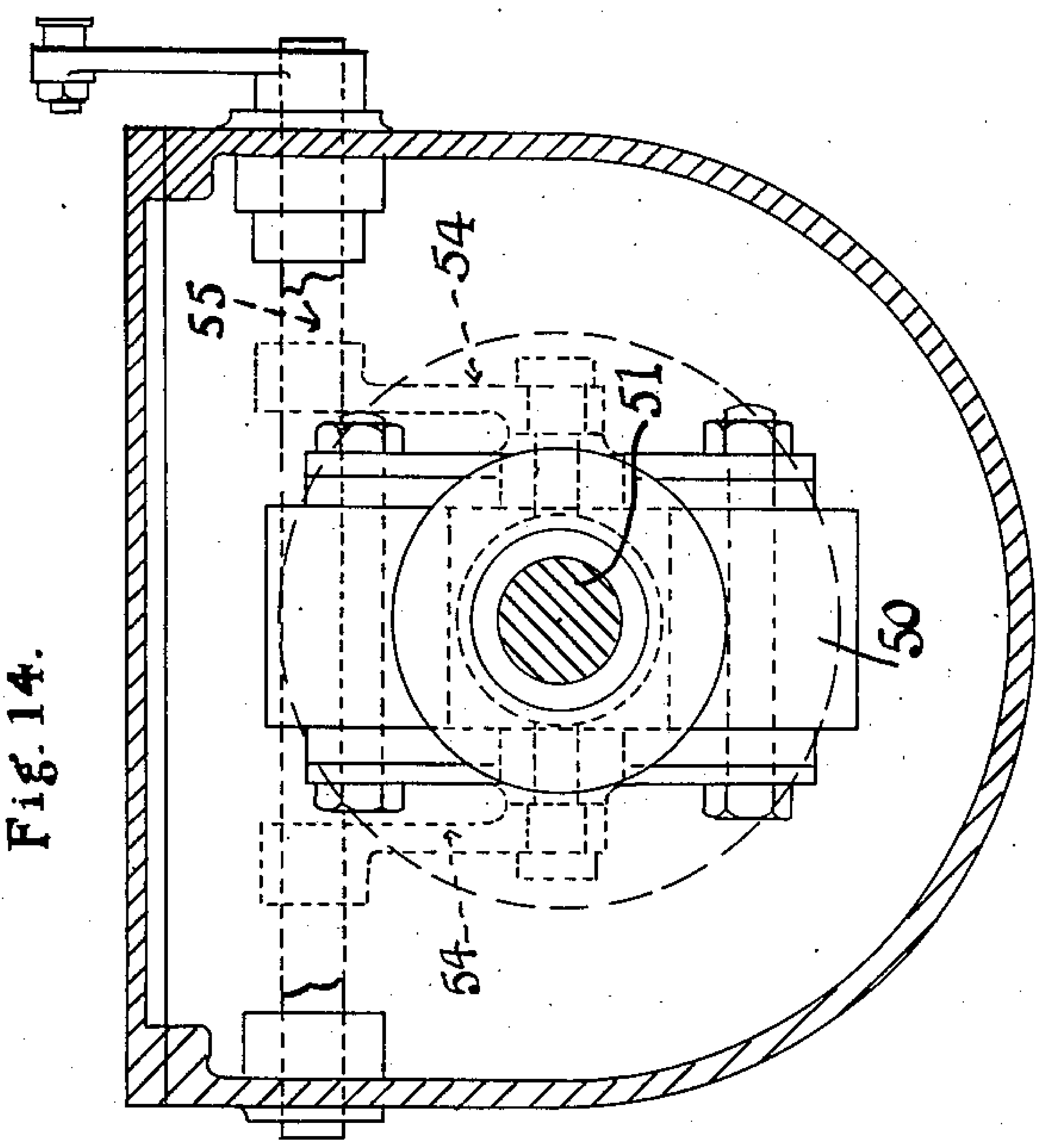
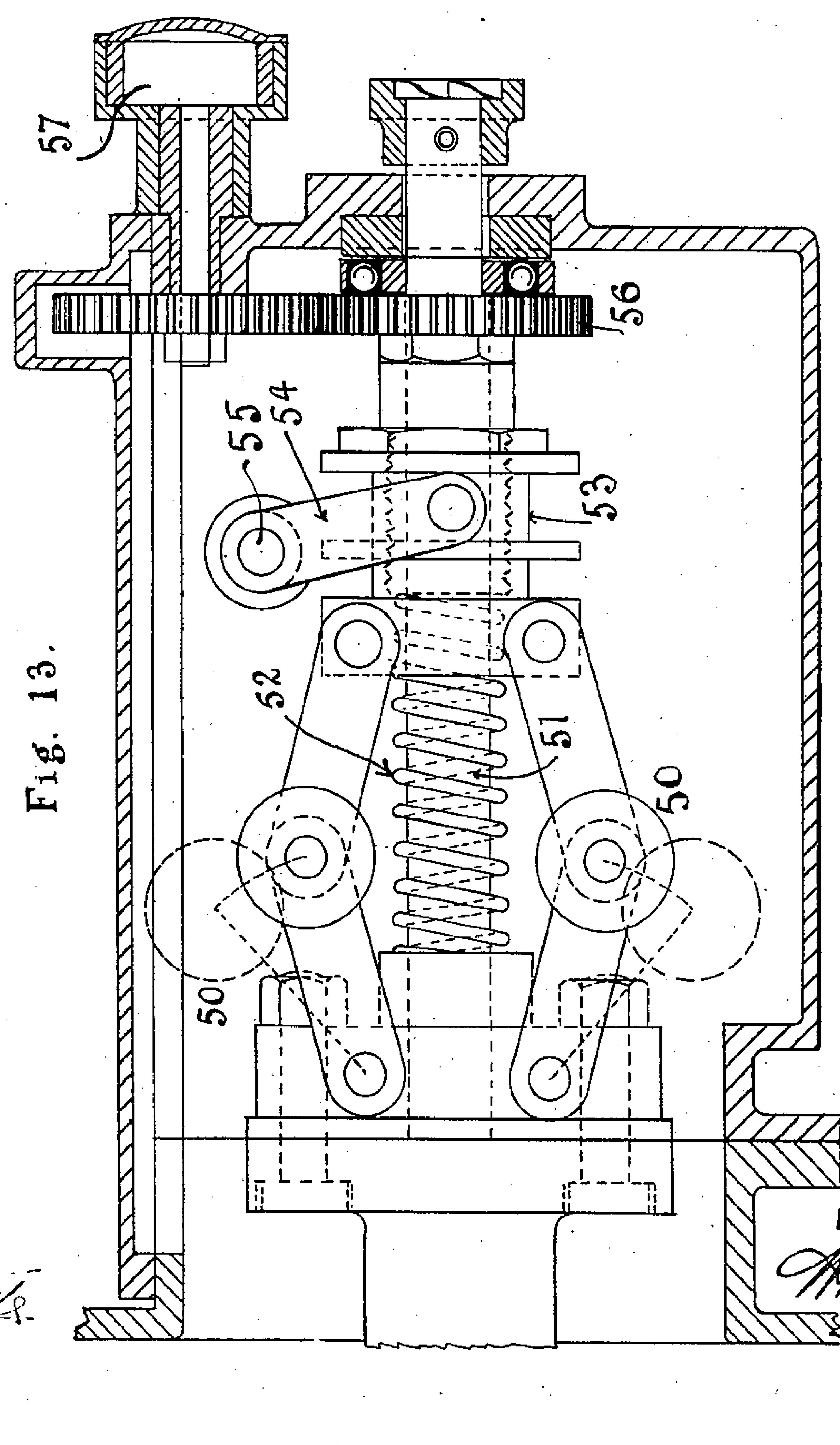


Fig. 13.



WITNESSES

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W. P. Burke

INVENTOR:
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BY *[signature]*
HIS ATTORNEY

UNITED STATES PATENT OFFICE.

NORMAN MACBETH, OF ST. ANNES-ON-THE-SEA, ENGLAND.

INTERNAL-COMBUSTION ENGINE.

No. 868,202. **Specification of Letters Patent.** **Patented Oct. 15, 1907.**

Application filed March 6, 1907. Serial No. 360,961.

To all whom it may concern:

Be it known that I, NORMAN MACBETH, a subject of Great Britain, residing at Dunallan, St. Annes-on-the-Sea, in the county of Lancaster, England, engineer, have invented new and useful Improvements in and Connected with Internal - Combustion Engines, of which the following is a specification.

My said invention relates to internal combustion engines of the two stroke cycle type in which two explosion cylinders placed parallel are used connected by a common combustion space and in which the inlet ports are placed in one cylinder and the exhaust ports in the other cylinder the pistons in such cylinders uncovering and closing the inlet and exhaust ports.

The object of the invention is, among other features, to devise a vertical single-acting engine of the inclosed kind which shall comprise a thoroughly well-balanced set of working parts giving a constant downward pressure on the connecting rods and crank shaft and adapted for running with the splash or forced system of lubrication. The combination is such that the greatest strains upon the crank-shaft are sustained by those portions nearest the bearings supporting the crank-shaft and the general design is such that the engine is capable of running at a very high speed with little vibration. I may also under my invention make provision for scavenging out the exhaust gases by laying a stratum of air before the fuel charge, which, when required, is done by means of a charging pump which in all cases supplies the fuel and air and is constructed and disposed in a particular fashion, while provision may also be made for the admission of air through a ring of ports or air intake in the cylinder of said charging pump.

I will refer in the first place to the figures on the attached nine sheets of drawings which show the full details of my invention.

In the said drawings:—Figure 1 is an elevation partly in section of an engine or of one unit of the simplest form of motor in accordance with my invention and such motor may comprise one or more units or engines. In this form of my invention no special provision is made for scavenging out the exhaust, but, apart from this, the combination is such as presents all the characteristics of my engine. Fig. 1ª is an elevation partly in section of a similar form of motor to that shown in Fig. 1 and comprising 3 units or engines but in this case special provision is made for scavenging out the exhaust and the charging pump has a ring of air holes through which the pump may obtain a full supply of air for charging the air reservoir shown. A separate air inlet to the air reservoir is also indicated which may be used in connection with or without a ring of air holes. Fig. 2 is a vertical section of the cylinder casting (seen in Fig. 1ª) the view being taken at right-angles and through the center of the combustion space. Fig. 3 is a plan view of Fig. 1 partly in section. Fig. 3ª is a section on the line X—X Fig. 1ª. Fig. 4 shows a sectional elevation of a slightly modified form of engine wherein special provision is made for scavenging out the exhaust and in which the fuel and air are drawn into chambers in connection with the inlet ports which chambers are separated by a partition in connection with the inlet port belt and only communicate through the inlet port spaces. Fig. 5 is a sectional plan view of Fig. 4 mainly taken on a level with the ring of inlet and exhaust ports. Fig. 6 shows a sectional end elevation of Fig. 4. Fig. 7 is a vertical section of another slightly different form of my engine embodying the features of the invention and showing a modified form of charging pump and piston. Fig. 8 is a sectional plan view of the upper part of Fig. 7, while Fig. 9 shows a vertical section of Fig. 7 drawn at right angles. Fig. 10 is a detail section of a suitable form of air and gas valve with a throttle valve, which latter valve may be automatically controlled from the governor or otherwise. Fig. 11 is a sectional view of a suitable form of feed pipe or fuel chamber jacketed so as to permit the exhaust gases to pass around, the view showing an air inlet valve and liquid fuel supply pipe in connection therewith. Fig. 12 is another view of the attachment represented in Fig. 11 but shown at right angles. Figs. 13 and 14 are views of a suitable governing device for regulating or controlling the supply of gas or air to the motor.

I will now fully describe the whole of the features embodied in my invention. In the case of every engine made in accordance with my invention I employ two inverted explosion cylinders 1, 2, having a common combustion space 3 the whole forming a set which set may be cast in one, the cylinders having their axes parallel as clearly shown in Fig. 1. The fuel inlet ports 4, are situated in the explosion cylinder 1 and the exhaust ports 5 in the other explosion cylinder 2. Preferably the two sets of ports are situated about mid-way in the length of the explosion cylinders and so are uncovered by the pistons 6, 6, which work in the explosion cylinders near the end of the expansion stroke. The pistons 6, 6 are of equal diameter, move in unison, have equal length of stroke, and they open and close their respective ports to an equal extent. Similar connecting rods 7, 7 connect the pistons 6, 6 to similar lengths of crank 8, 8 upon a common crank shaft 9. The explosion cylinder pistons 6, 6 are of such a length that they still cover the inlet and exhaust ports at the inner end of their stroke. I place the two crank pin bearings for the explosion cylinders next to the bearings 10, carrying the crank shaft 9. Both the inlet and exhaust ports 4, 5 are in belts around the respective cylinders and such belts form as near as possible a complete circle of annular or other ports in each case.

In connection with the explosion cylinders I apply a single acting charging pump 11 which supplies the explosive mixture, and the scavenging air, (where air scavenging is desired). The fuel is by the aid of this charging pump drawn in through a fuel chamber and the fuel and air are forced by said pump through the inlet ports into the explosion cylinders. The charging pump is in all cases located centrally between the explosion cylinders 1, 2 but at a lower level and with its axis in the same vertical plane. The charging cylinder piston 12 has however an equal length of stroke to the other pistons and is connected to a central crank 13 intermediate of the other two cranks but on the same common crank shaft which has its axis in the same plane as the three cylinders, said crank being however oppositely arranged or set at a distance of 180° to the other two cranks. Thus the explosion pistons and the charging piston move in opposite directions but in a common plane. I make all the three cranks 8, 8, 13 of equal length and of such dimensions in the webs and crankpins that the two outside cranks balance the central crank. The two explosion pistons 6, 6 are together of equal weight with or balance the weight of the charging piston 12. By the construction outlined I am enabled to lower the situation of the charging cylinder and place the same lower on the crank shaft side of the inlet ports so that I dispose the charging cylinder where the explosion cylinders need not be water-jacketed. This disposal of the charging cylinder compels me to shorten the connecting rod 14 for same but it is so proportioned as to equal the combined weight of both explosion piston connecting rods. The charging cylinder is not water-jacketed. As the undersides of the two explosion cylinders and the charging cylinder are open to the crank chamber, the piston, the connecting rods, &c., of all three cylinders, receive lubrication from below without danger of too great an amount of lubricant coming in contact with the combustible charge either in the explosion cylinders or in the charging pump, which is desirable. The lower part of the crank chamber 15 is removable and may join the upper on a line with the center of the crank shaft as the drawings Fig. 1 and Fig. 1ª show.

By the combination described the explosion cylinders can be kept so close together that the combustion chamber connecting the upper ends is not too great to give sufficiently high compression pressure to the fuel charge before ignition when sufficient area of channel is allowed through the combustion space to avoid undue throttling during charging and exhausting. The disposition of and space occupied by the charging cylinder or pump permits sufficient room between the explosion cylinders to allow of a continuous belt or ring of inlet and outlet ports 4 and 5 of large area (without occupying much of the length of the cylinder) and of passages 16, 17 to connect same and also to allow of a water-jacket being used around the exhaust. By having a large area in the inlet and outlet ports and in the combustion channel 3 high piston speeds are made possible. A further advantage of the desired arrangement is that it allows of the capacity of the charging cylinder 11 being greater than the combined capacities of the explosion cylinders 1, 2, and of the admission of a greater weight of charge to the explosion cylinders than is possible in engines with similarly arranged explosion cylinders but in which the explosion cylinders themselves are made to form the charging pumps by using the lower sides for such purpose. By this means I can completely or sufficiently fill the explosion cylinders with a combustible charge. With the charging cylinder being single acting on the top side of the piston, the piston rings of it and of the explosion cylinders tend to prevent the exhaust gases escaping (by way of the crank chamber 15) to the acting side of the pump so that the fuel mixture and air charge is not contaminated by exhaust gases before entering the explosion cylinders.

The disposition of the charging pump 11 in all the examples shown only throws the strain of such pump upon the central portion of the crank shaft 9 which is necessarily considerably removed from the supporting bearings and I thus avoid the great bending strain thrown on that part of the crank shaft by engines having an explosion piston connecting rod bearing directly on the central part of the crank shaft.

In addition to the balancing of the explosion pistons and connecting rods against the charging piston and rod I balance the corresponding heads or ends and the bodies of the connecting rods and other corresponding parts so as to get as nearly perfect balancing as possible and so produce a practically vibrationless engine. All the forms of engine shown in the drawings possess the foregoing characteristics which result in the production of a compact, well-balanced, vertical, single-acting engine capable of being run at high speeds on a two stroke cycle. The engine shown in Fig. 1 (and of which Fig. 3 will serve as a plan) is intended to be of a non-scavenging type and in such case the charging pump 11 derives the fuel from a feed pipe 18 in connection with each unit, which feed pipe may be connected at 27. The feed pipes 18 may have inlet or back pressure valves or other appliances for admitting the supply of fuel to the feed pipes 18. These back pressure valves may be closed by springs and mounted each in its separate compartment 19 (see Fig. 3) which compartments are in communication with a lower supply chamber common to all, the inlet 23 to which is connected with the carbureter. Covers 25 allow access to the back-pressure valve chambers. The center supply pipe 18 being of comparatively short length I make up its capacity by a vessel or pipe extension 26 so that the entire capacity corresponds nearly with the feed pipes 18 on either hand whereby the pressures in the reservoirs are kept uniform. It will be understood that the suction on the fuel takes place through and around the inlet port belt. The exhaust takes place through the exhaust passages 17 through exhaust outlets, as for instance it may be the outlets 20. This describes my invention so far as the construction where non-scavenging engines are concerned.

When it is desired that effective scavenging by air should take place, as is intended to be the case in the engines depicted in Figs. 1ª, 4 and 7, then I cause the piston of the charging cylinder 11 to draw in the scavenging air on the outward stroke as well as the fuel. The fuel is drawn into a fuel chamber of a suitable kind such as 18 and the air into an air reservoir which fuel chamber and the air reservoir are connected past or by the inlet ports of the explosion cylinders. The air and fuel are so drawn in on the outward stroke, and, on the inward stroke, the charging piston 12 compresses the said air and fuel in the separate chambers for each in connection with the inlet port belt, that is the fuel chamber and the air reservoir, and so the explosion cylinders receive the charge slightly compressed.

On the crank shaft side of the inlet and exhaust port belts, or in the space over and surrounding the charging cylinder barrel, I form an air reservoir 24, already mentioned, which is in connection with the charging cylinder 11 and also the inlet port belt as clearly seen in Figs. 1ª, 2 and 6. Such air reservoir may be cast with the cylinders or separately applied in connection therewith. This reservoir 24 receives the greater portion of the air drawn in by the charging piston and may surround the three cylinders, that is, the charging cylinder and the lower parts of the explosion cylinders. The inlet port belt channel 16 is also connected with the before mentioned fuel chamber as by way of example at the opening 27 and such fuel chamber is of some capacity and may consist wholly or partly of the space in the pipe connecting the inlet fuel valve with the inlet port belt. This is as represented in Fig. 3 where the pipes 18 in communication with the channels 16 may conveniently serve as the fuel chambers. There is however no constant channel of communication between the air reservoir 24 and the fuel chamber in each case save past the port channel in the inlet port belt, that is, through and around the channel 16, see Figs. 3 and 3ª. The suction stroke of the charging piston draws fuel into said fuel chamber conveniently through a valve towards its remote end, as already mentioned, and when (gas is the fuel) all the air is also drawn into the air reservoir through a separate air valve, the delivery end of which may be coupled say at 28 so as to deliver into said air reservoir 24. Thus, the fuel chamber and air reservoir have each their separate inlets, the fuel chamber through its valve, and the air reservoir through 28. A form of suitable combined gas and air valve for the purpose is shown in Fig. 10 where the air valve 29 is guided and mounted on a spindle 30 normally held down by a spring 31. Through the spindle 30 a second spindle 32 passes, which is also acted upon by a spring 33, this second spindle carrying the gas valve 34 while a throttle valve 35 (automatically or otherwise controlled) is fitted in connection with the gas supply. Either valve may move independently while the upward movement of the gas valve compresses the spring 33 and so tends to raise the air valve from its seat. The construction permits the valves to seat themselves independently and provides for unequal expansion. The air valve is seated on a plug or seat 36 while the gas valve is reached through a cover 37. This valve attachment is very suitable for use with the engines shown in Figs. 4 and 7.

When using petroleum or other oil, for the engines illustrated, I dispense with any considerable supply of air in connection with the fuel supply and use the separate air inlet valve at 28 by itself or in conjunction with the ring of air ports 21 towards the base of the charging cylinder 11 which, as already described, are disposed so as to be uncovered by the piston towards the lower end of the stroke and which together or separately may serve for supplying the bulk of the air. Access for air to the ring of air ports 21 may be through screens 22. The piston 12 shown in Fig. 1ª being shallow has two ears or extensions 12ª which are formed with holes to register with the holes 21 in the cylinder when such exist at the time air is admitted, but in the other figures, the piston is supposed to uncover the air ports 21. When using air ports 21 to admit the air I cause a strong suction through the carbureter or fuel spraying device in connection therewith which suction also allows a large access of air to charge the air reservoir 24 to somewhere near atmospheric pressure during or upon completion of the outward stroke of the charging piston. By the final access of air through the holes 21 I also obtain a full charge in the explosion cylinders whether the engine is fully loaded or not thus maintaining a high compression pressure before ignition in the explosion cylinders. I admit with the liquid fuel into the fuel chamber a sufficient quantity of air to carry same but not necessarily enough to support combustion. I may in conjunction with the ring of air ports 21 in connection with the charging pump use an air inlet valve at 28 in connection with the air reservoir 24 as will be obvious or the air ports 21 may be omitted and the greater quantity of the air may be admitted at 28.

Upon completion of the suction stroke of the charging piston the fuel chamber is charged with fuel, and the air reservoir with air, save such portion of fuel mixture as may be drawn into the inlet port belt channel 16 and partly also through same into the the air reservoir which fuel mixture however lodges near the inlet port belt. With the return stroke, the charging piston compresses the whole contents of the fuel chamber, the port belts, and the air reservoir, and any fuel mixture which has passed into or through the port belt being more adjacent to the latter is forced back into or towards the fuel chamber together with a quantity of more or less pure air which ultimately serves along with a portion of the air in the air reservoir to scavenge the exhaust gases out of the explosion cylinders. Towards the completion of the inward stroke of the charging cylinder piston the explosion pistons have also arrived in such a position as to open the inlet and exhaust ports and the slightly compressed contents of the fuel chamber and air reservoir escape into the explosion cylinders and the exhaust from a previous explosion escapes from the cylinders. This exhaust is scavenged by a stratum of air only, first passing through the inlet ports said stratum being partly in the air which has surged back the fuel mixture into the fuel chamber, which scavenging air is followed by the fuel mixture and air. The pressure of the following incoming fuel mixture also serves to expel the exhaust gases. A sufficient mixing of the charge then takes place during the compression stroke whereupon the charge is exploded.

The forcing or surging back of the fuel by air pressure into the fuel chamber from which the inlet port belt derives its supply, and which forcing or surging back is due directly to the action of a charging pump in constant communication with such chamber, is a most important feature because it sweeps back the fuel lodging in and about the inlet ports leaving them filled with air and interposes a stratum of air which air is first liberated and admitted to the cylinders and serves to scavenge out the exhaust gases and to give a richer charge and also to prevent premature ignition of the charge and back firing into the air and gas chambers. As the charging pump can be of greater capacity than the explosion cylinders a considerable volume of air can be used for this scavenging operation.

In cases where heavy oils are used, the fuel chamber communicating with the inlet port belt may be heated by being more or less completely jacketed, through which jacket I should arrange for the exhaust gases or a portion thereof to pass. Such an attachment is indicated in Figs. 11 and 12 wherein the fuel chamber is lettered 18ª. This fuel chamber has a surround or jacket 38 the inlet end 20ª of which is coupled to the exhaust outlet or discharge so that the exhaust gases in escaping communicate heat to the fuel chamber. The appliance is shown fitted with a liquid fuel pipe 39 which discharges through a hole or holes 40 in the seat of the back-pressure valve 41 and also with a circular grid-iron air valve 42 operated by a lever handle 43 by means of which the volume of air admitted may be automatically controlled and the fuel supply accordingly regulated. This lever handle 43 may by suitable connections be worked from a governor. The back-pressure or suction valve 41 controls the delivery into the fuel chamber 18ª. The fuel chamber heating arrangement Fig. 11 may be looked at with relation to Fig. 5, when its application will be apparent, 27ª coming opposite 27 (Fig. 5) and 20ª (Fig. 11) opposite 20 (Fig. 5). By so heating the fuel chamber, the fuel vapor supply is kept hot in the fuel chamber and ready for admission to the explosion cylinders. By forming the inlet valve with a hole or holes in its seat as described and admitting the fuel therethrough I sufficiently spray the oil, petrol, or other liquid fuel; or a carbureter and throttling arrangement of any known construction for supplying and controlling the amount of fuel required can be applied outside of the inlet valve to the fuel chamber.

I water-jacket the explosion cylinders 1, 2, above the inlet port belt and around the actual combustion chamber 3 itself, and the water-jacket may also surround the exhaust port belt. It is so shown surrounding the exhaust port belt, the explosion cylinders, and combustion space in Figs. 4 and 7, while in Fig. 1 and Fig. 1ª it only surrounds the explosion cylinders and extends over the combustion space. To allow of unequal expansion of the explosion cylinders or walls of the water-jacket I may form the water-jacket with a flexible diaphragm or cover 44 arranged preferably at the top and attached at the outside to the side walls of the water-jacket but only attached to the combustion channel 3 where the ignition plug passes through at 45 or where the compression relieving valve or the like passes through.

When higher compression pressures are desirable without having to increase the length of stroke or reduce the number of revolutions I decrease the capacity and length of combustion space while I maintain the requisite capacity of the charging pump by boring its working barrel from two centers placed equidistant from the working plane of the explosion cylinders the centers being so wide apart that the two bores join and form two segments of more than half a circle each, leaving sufficient width or space to admit the gudgeon end of the connecting rod and the pin for same which is held by the charging piston (see Fig. 9). The result is that I obtain a charging cylinder of approximately an 8 shape as is indicated in Figs. 7 and 8 where the cylinder bored from two centers is lettered 11ª. I form the charging piston 12ª from two cylinders or bodies cut off flat where they unite and turned so as to fit the two bores of the pump barrel 11ª. The two halves of the 8 shaped piston are bolted or otherwise secured together by bolts 46 and can be separately turned. The two halves of the piston 12ª are cut with the usual grooves to contain packing rings. The packing rings may be cut so that they end close to the junction of the two connecting parts of the piston. The gudgeon pin for the connecting rod is held in any suitable way between the halves of the piston. This form gives a considerable charging pump piston area while it permits me to bring the explosion cylinders so much closer together and consequently to shorten the combustion space, thus decreasing its capacity and causing a greater compression of the fuel charge before ignition.

In forming the inlet port belt where the size of the engine permits I provide a partition *p* which serves as a division wall between the fuel chamber and the air reservoir and so I obtain two adjacent belts 16ª, 24ª, the only channels of communication between the two chambers being the ports 4 themselves passing through the cylinder walls and across or past the said partition. Thus the upper portions of the port holes communicate with the fuel chamber of whatever form while the lower portions communicate with the air reservoir 24. In large engines such a division or partition may be formed by a loose plate or casting 47, as is indicated in Figs. 7 and 8, such casting being fitted and fastened in the main belt, access for fitting being conveniently had through a removable door or cover 48; or the partition plate may be cast in position. In small engines it may be cast in the main belt space, see Figs. 4 and 5, and where the holes forming the inlet ports 4 are drilled in the walls of the cylinder the parts drilled away in the partition rib may be replaced by fins 47ª upon plugs 49 the outer ones screwed into tapped holes in the wall of the outer jacket while the inner ones 47ᵇ are pushed or screwed into position through the port holes and their shanks engage holes formed to receive them. The drilled holes 58 facing the exhaust ports 5 are made up by simple screwed plugs 59. To facilitate such mode of making the ports by drilling from the outside in the case of small engines I arrange the port holes in the belt for inlet and exhaust in even numbers of holes and I form the outside walls semi-circular (see Fig. 5) or polygonal to permit of the port holes through the sides of the walls of the explosion cylinders which are inside nearest the charging cylinder being drilled right through the cylinders from the corresponding opposite outside ports. In very small engines or motors I so form the inlet belt that only a narrow area of belt channel 16 unites the air reservoir and gas chamber so as to avoid any considerable mixing of the fuel charge with the scavenging air which narrow area of belt channel in constant communication with the pump is observable from Fig. 3 and Fig. 3ª.

I may cast the two explosion cylinders and common combustion space together with the walls for water-jacket and air reservoir in one casting, and apply the charging pump barrel separately, this being a very convenient way; or I may cast the pump cylinder along with the main casting.

In Figs. 13 and 14 I show a suitable governing or controlling apparatus which may be fitted on the main shaft and serve to automatically control the supply of gas by regulating the opening of the throttle valve 35 in the gas supply pipe, or the air valve 42 where liquid fuel requiring vaporization is used. This automatic controlling arrangement consists of a governor 50 mounted on a shaft 51 coupled to the main shaft, the governor expanding against the action of a spring 52 and actuating a sliding sleeve 53 which works lever arms 54 mounted on a spindle 55 the movement of which through suitable connections operates the gas supply throttle valve or the air valve to the vaporizer or air inlet valve to air reservoir as will be understood. The gear wheel 56 on the shaft 51 is intended to drive the commutater 57 of the ignition sparking arrangement.

I will for the sake of clearness briefly describe the cycle of operations of the various engines illustrated. In the non-scavenging engine Fig. 1, the charging pump supplies the fuel mixed with air, or serves to supply fuel mixture and air sucked in through separate inlet valves if desired, the charge after compression in the chamber or space in connection with the charging pump and after passing into the explosion cylinders being further compressed by the explosion cylinder pistons into the combustion chamber prior to firing as will be understood the exhaust ultimately escaping through the ports 5 into the exhaust pipes 20 when the piston 6 uncovers same.

In the case of a gas engine where scavenging is desired the charging cylinder piston on its downward stroke draws gas through the gas supply valve of whatever kind into the gas or fuel chamber and partly through the inlet port belt for light loads and also partly through into the air reservoir in the case of heavy loads on the engine. Simultaneously air is drawn into the air reservoir through the separate air valve which as mentioned may be fixed at the port 28, and finally, if such air holes as 21 be used, the remaining air to bring the contents to atmospheric pressure is admitted through the air holes 21. On the return stroke, the contents of both gas chamber and air reservoir are compressed and the gas is forced back into the gas chamber so that nearly pure air lodges in the space adjacent to the inlet ports of the explosion cylinder. Upon the completion of the inward stroke of the charging cylinder piston the explosion cylinder pistons have opened the inlet and exhaust ports and the exhaust gases commence to pass out. The pressure in the gas chamber and air reservoir causing the new charge to flow into the explosion cylinders, the pure air for scavenging passing in first followed by the explosive mixture, the pressure helping to expel the exhaust gases. Such a volume or weight of air and fuel vapor is forced in as to completely or sufficiently fill the explosion cylinders and their combustion space with a charge which is then ready for complete mixing and which by the inward stroke of the pistons is mixed and compressed and when wholly or partly compressed is ignited electrically or otherwise so that combustion takes place causing an expansion of the gases and impelling the explosion cylinder pistons on their outward stroke, at the end of which the spent gases are exhausted and a new charge passes in as related. In the case of engines using liquid fuel a similar action takes place except that the air valve is or may be so controlled that only such portion of pure air as may be desired is admitted into the air reservoir. When the charging cylinder piston nearly reaches the end of its outward stroke it uncovers the ring of air holes 21 in the charging pump cylinder when such holes exist. Such final uncovering of the air holes allows of a sufficiently strong suction at the inlet valve or valves to cause any spraying or carbureting apparatus of an ordinary or well-known description to spray or volatilize the fuel charge on its entering the fuel chamber with the necessary air required for this purpose while it allows of the final pressure in the air and fuel reservoirs nearly approaching atmospheric pressure. Engines such as described are capable of running in either direction by suitably timing the ignition during the cycle, and are eminently suitable for use for automobiles, launches, and for driving dynamos, and such like, where high speeds in revolutions are desirable. A number of units such as described may be arranged to act on one crank shaft so as to give a number of impulses during one revolution.

I declare that what I claim is:

1. An internal combustion engine having parallel explosion cylinders, admission ports in one cylinder, exhaust ports in the other cylinder, a common combustion space, a centrally disposed air and fuel charging pump located nearer the crank shaft, pistons in said explosion cylinders and working parts connected therewith, a charging pump piston and working parts, said explosion cylinder cranks pistons and working parts being set at opposite angles to and balancing the charging pump crank piston and working parts for the purposes and as set forth.

2. An internal combustion balanced engine of the indicated kind having two parallel explosion cylinders admission ports in one cylinder, exhaust ports in the other cylinder, a common combustion space, pistons in said cylinders, an air reservoir, an air inlet, a fuel chamber and fuel supply devices connected therewith, and a centrally disposed single acting air and fuel charging pump connected to both fuel chamber and air reservoir comprising a pump barrel located towards the crank shaft and a plunger moving therein substantially as described.

3. An internal combustion balanced engine having parallel explosion cylinders, admission ports in one cylinder exhaust ports in the other cylinder, a common combustion space, a fuel inlet, an air reservoir, an air inlet to said air reservoir, a single acting centrally disposed charging pump, a pump barrel, a pump plunger, explosion pistons in said explosion cylinders, the pistons cranks and working parts balancing each other and being set at opposite angles, for the purposes and substantially as described.

4. A two stroke cycle balanced engine of the indicated type having a fuel chamber, and a separate air reservoir, connected together by a narrow channel past the fuel inlet ports, an inlet to said fuel chamber, fuel supply means in connection with said fuel chamber, and an air inlet device to said air reservoir, and one single acting centrally disposed charging pump, all in combination, and whereby the fuel and a portion of the air can be forced back on the return stroke of the pump piston into said fuel chamber so that air first enters the explosion cylinders to scavenge out the exhaust gases substantially as described.

5. A two stroke cycle balanced engine of the indicated type having parallel explosion cylinders, inlet ports in one cylinder, exhaust ports in the other cylinder, a fuel inlet chamber and a separate air reservoir with its air inlet, a partition about the center of the inlet ports of said explosion cylinders and intermediate of said fuel chamber and

air reservoir, a constant channel of communication in connection with the inlet ports and a centrally located single acting air and fuel charging pump, for the purposes and substantially as described.

6. A two stroke cycle balanced engine in one or more units each unit having parallel explosion cylinders 1, 2, inlet ports in cylinder 1, outlet ports in cylinder 2, a common combustion space 3 explosion pistons 6, 6 in said cylinders, cranks and connecting rods and a single acting centrally located charging pump and supporting bearings adjacent to the explosion piston cranks, and a casing 15 all in combination and as shown in Figs. 1 and 3 of the drawings.

7. A two stroke cycle balanced engine in one or more units each unit having parallel explosion cylinders 1, 2, inlet ports in cylinder 1 outlet ports in cylinder 2, a common combustion space 3, explosion cylinder pistons 6, 6, in said cylinders, cranks and connecting rods, a fuel chamber 18 with fuel inlet, and an air reservoir 24, the fuel chamber and air reservoir being connected by a narrow channel past the fuel inlet ports of the explosion cylinders, and a pump barrel 11, a ring of air holes 21 therein, a single acting air and fuel pump, a pump plunger, supporting bearings adjacent to the explosion piston cranks and an inclosing casing 15 substantially as described with reference to Figs. 1ª and 3 of the drawings.

8. A two stroke cycle balanced engine in one or more units each unit having parallel explosion cylinders 1, 2, inlet ports in cylinder 1 outlet ports in cylinder 2, a common combustion space 3 explosion cylinder pistons 6, 6 in said cylinders, cranks and connecting rods, a fuel chamber 18 with fuel inlet and an air reservoir 24 an air inlet 28 to said reservoir and a pump barrel 11, a single acting air and fuel pump plunger, supporting bearings adjacent to the explosion piston cranks and an inclosing casing substantially as described with reference to Figs. 1ª and 3 of the drawings.

9. A two stroke cycle balanced engine in one or more units each unit having parallel explosion cylinders 1, 2, inlet ports in cylinder 1 outlet ports in cylinder 2 a common combustion space 3, explosion cylinder pistons 6, 6 in said cylinders, cranks and connecting rods, a fuel chamber 18 with fuel inlet and an air reservoir 24, an air inlet 28 in said reservoir, and a pump barrel 11, a ring of air holes 21 therein, a single acting air and fuel pump, a pump plunger, supporting bearings adjacent to the explosion piston cranks, and an inclosing casing 15, substantially as described and shown in Figs. 1ª and 3 of the drawings.

10. A two stroke cycle balanced engine in one or more units each unit having parallel explosion cylinders 1, 2 inlet ports in cylinder 1 outlet ports in cylinder 2 a common combustion space 3 explosion pistons 6, 6 in said cylinders, cranks and connecting rods, a fuel chamber a fuel inlet thereto an air reservoir, an air inlet thereto, a partition 47ª intermediate of said fuel chamber and air reservoir and a single acting centrally located air and fuel pump, a pump plunger and supporting bearings, all the parts being in combination and as shown in Figs. 4, 5 and 6.

11. A two stroke cycle balanced engine in one or more units each unit having parallel explosion cylinders 1, 2 inlet ports in cylinder 1 outlet ports in cylinder 2, a common combustion space 3 explosion pistons 6, 6 in said cylinders, cranks, and connecting rods, a fuel chamber, a fuel inlet thereto, an air reservoir, an air inlet thereto, a partition 47 intermediate of said fuel chamber and air reservoir, with connecting channels through inlet ports of explosion cylinders, an 8 shaped pump barrel intermediate of said explosion cylinders, and an 8 shaped piston in said barrel a crank and connecting rod for said pump piston and supporting bearings, all substantially as described and shown in Figs. 7, 8 and 9.

12. A two stroke cycle balanced engine in one or more units each unit having parallel explosion cylinders 1, 2 inlet ports in cylinder 1 outlet ports in cylinder 2 a common combustion space 3 explosion pistons 6, 6, in said cylinders, cranks and connecting rods, a fuel chamber, a fuel inlet thereto, an air reservoir 24 an air inlet 28 thereto, a partition intermediate of said fuel chamber and air reservoir and a single acting centrally located air and fuel pump, a pump plunger therein and supporting bearings, all the parts being in combination and as shown.

13. A two stroke cycle balanced engine in one or more units each unit having parallel explosion cylinders 1, 2 inlet ports in cylinder 1 outlet ports in cylinder 2, a common combustion space 3 explosion pistons 6 6 in said cylinders, cranks and connecting rods, a fuel chamber, a fuel inlet thereto an air reservoir, a partition intermediate of said fuel chamber and air reservoir and a single acting centrally located air and fuel pump comprising a pump barrel, a ring of air holes 21 therein and a pump plunger, and supporting bearings for the crank shaft all in combination and substantially as described.

14. A two stroke cycle balanced engine in one or more units each unit having parallel explosion cylinders 1, 2 inlet ports in cylinder 1 outlet ports in cylinder 2, a common combustion space 3 explosion pistons 6 6 in said cylinders, cranks and connecting rods, a fuel chamber, a fuel inlet thereto, an air reservoir 24 an air inlet 28 thereto, a partition intermediate of said fuel chamber and air reservoir, and a single acting centrally located air and fuel pump comprising a pump barrel a ring of air holes 21 therein and a pump plunger, all in combination and substantially as described.

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

NORMAN MACBETH.

Witnesses:
RICHARD IBBERSON,
ALFRED YATES.