F. H. MERRILL.

AIR COMPRESSOR.

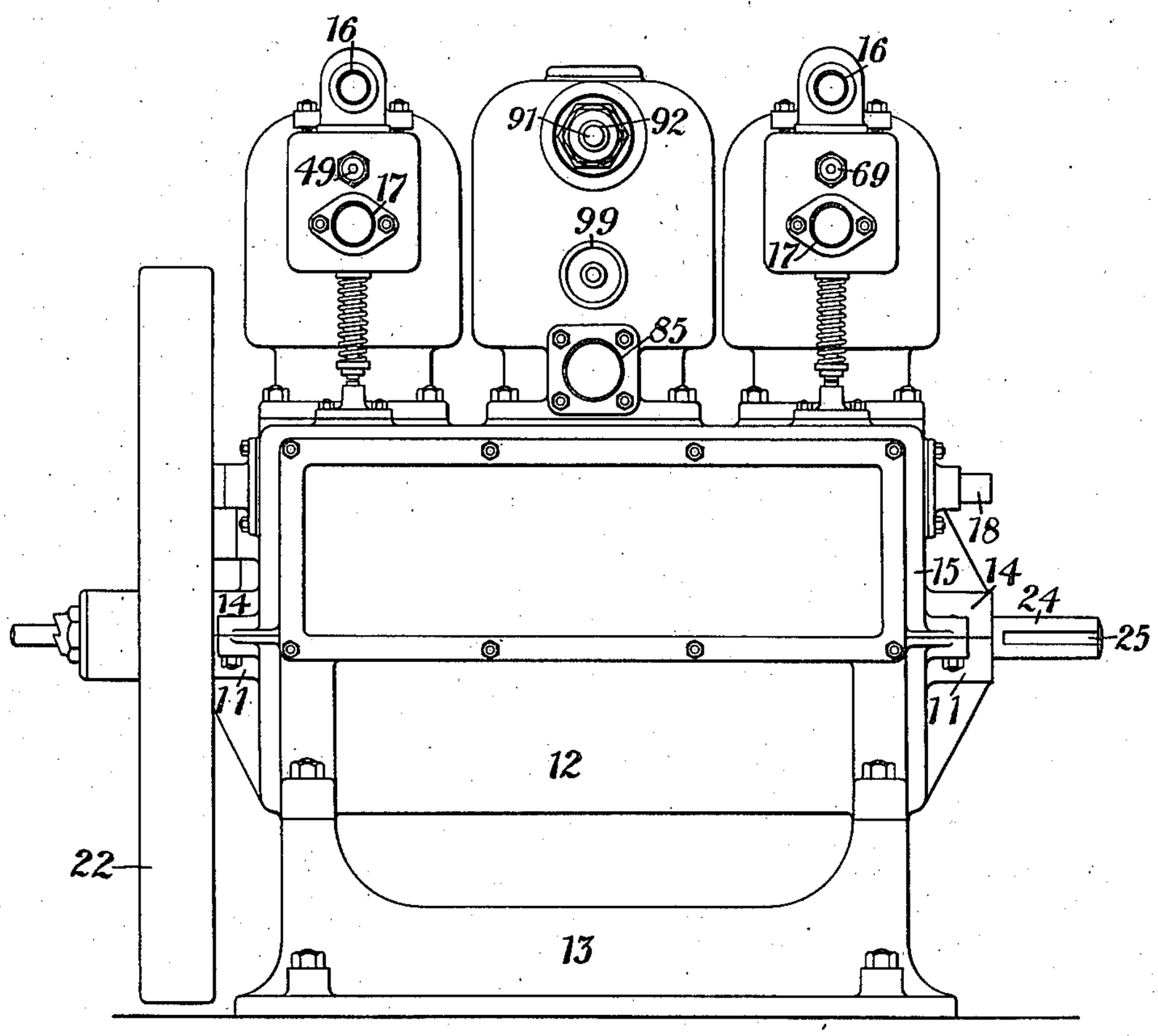
APPLICATION FILED MAR. 16, 1907.

963,788.

Patented July 12, 1910.

5 SHEETS—SHEET 1.

Fig. 1.



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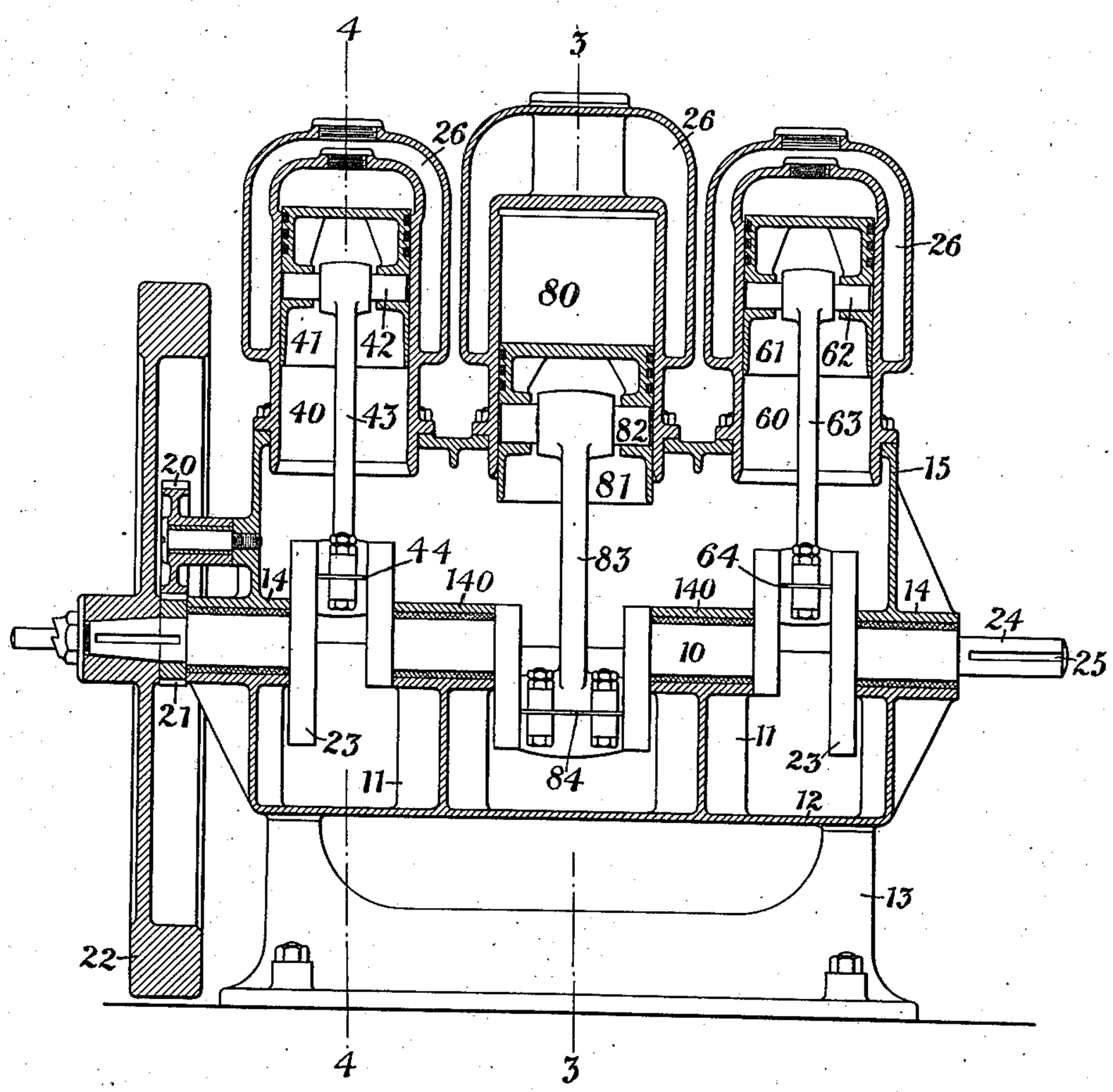
5 SHEETS—SHEET 2.

FIG. 2.



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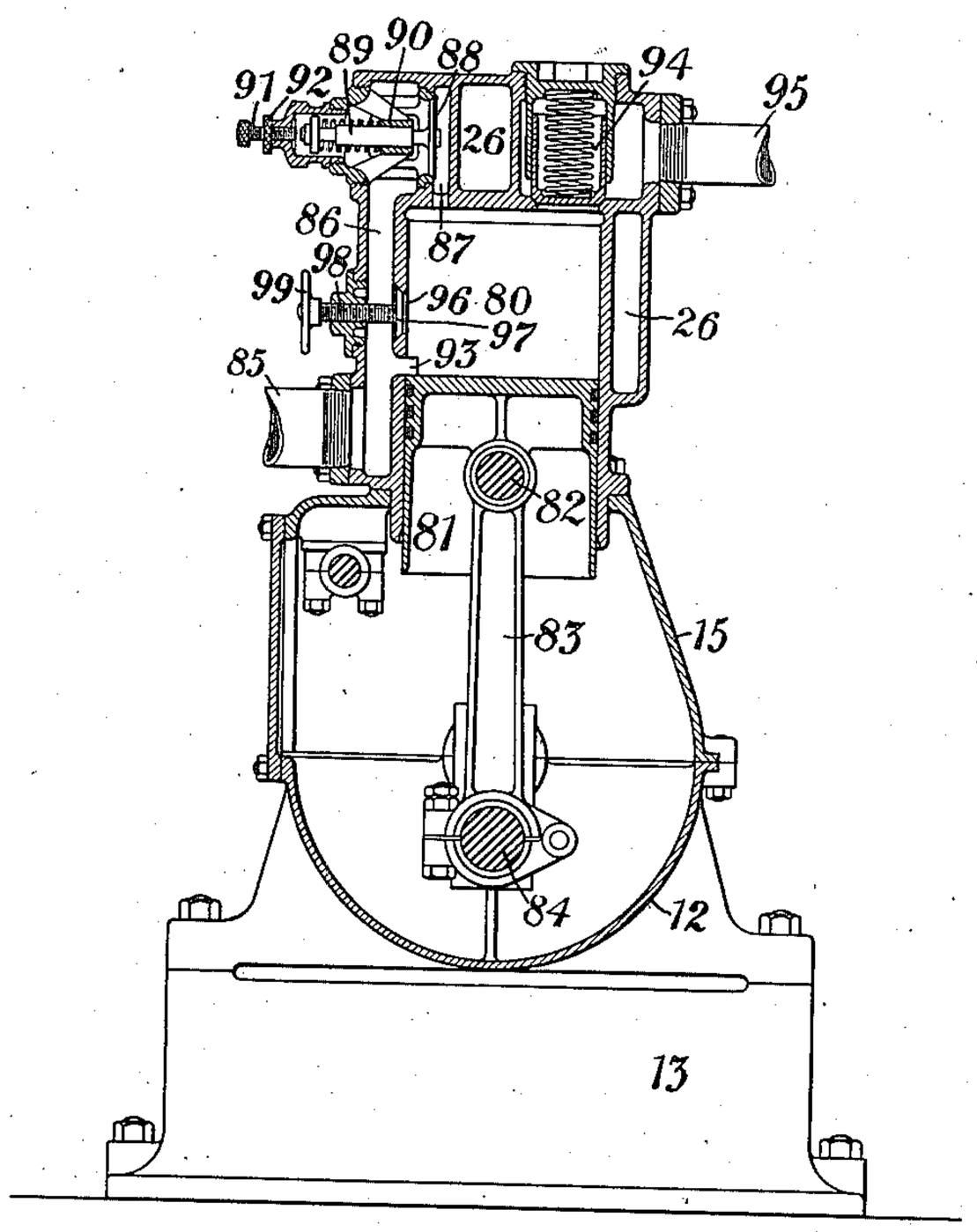
5 SHEETS—SHEET 3.

FIG. 3.



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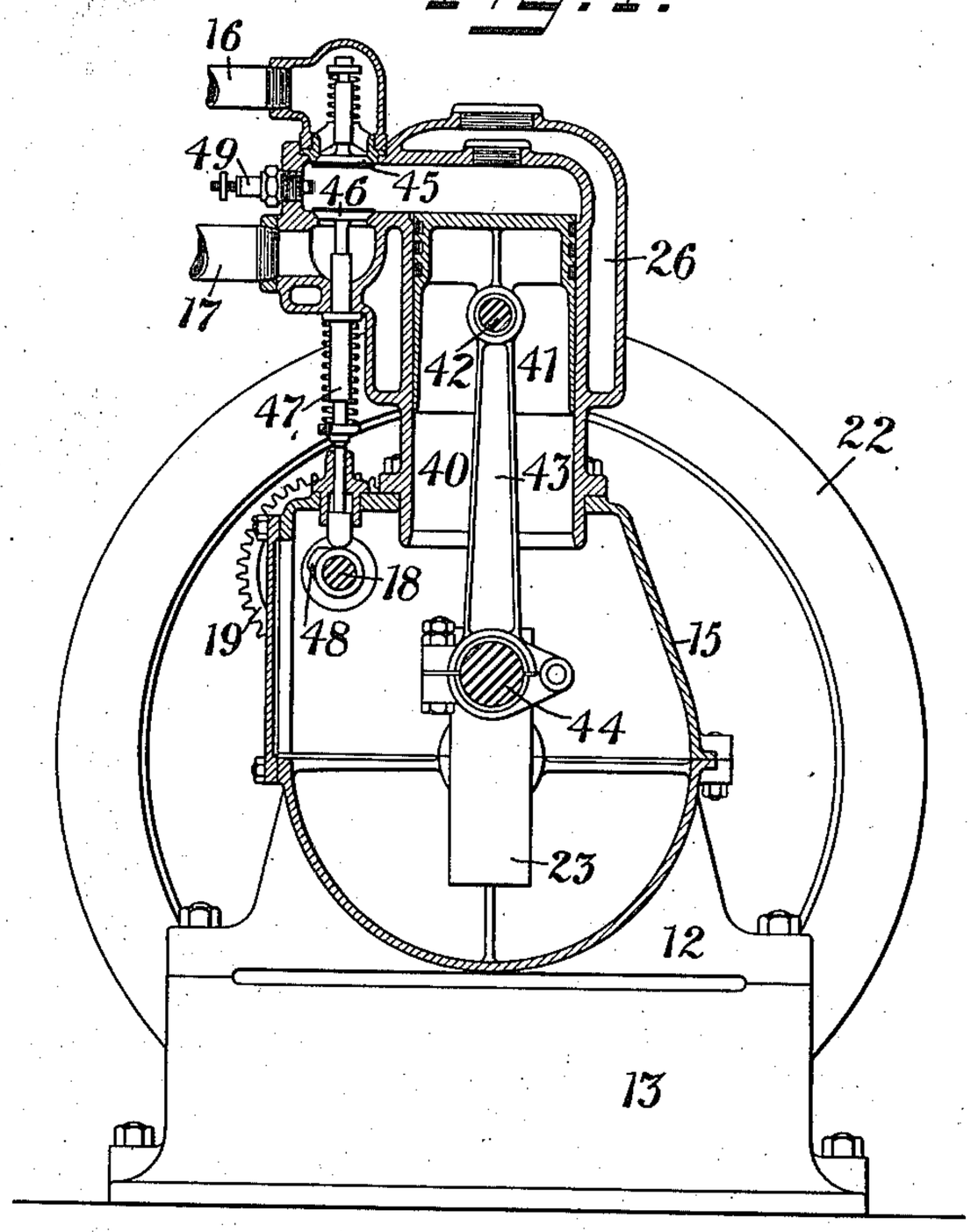
5 SHEETS—SHEET 4.

FIG. 4.



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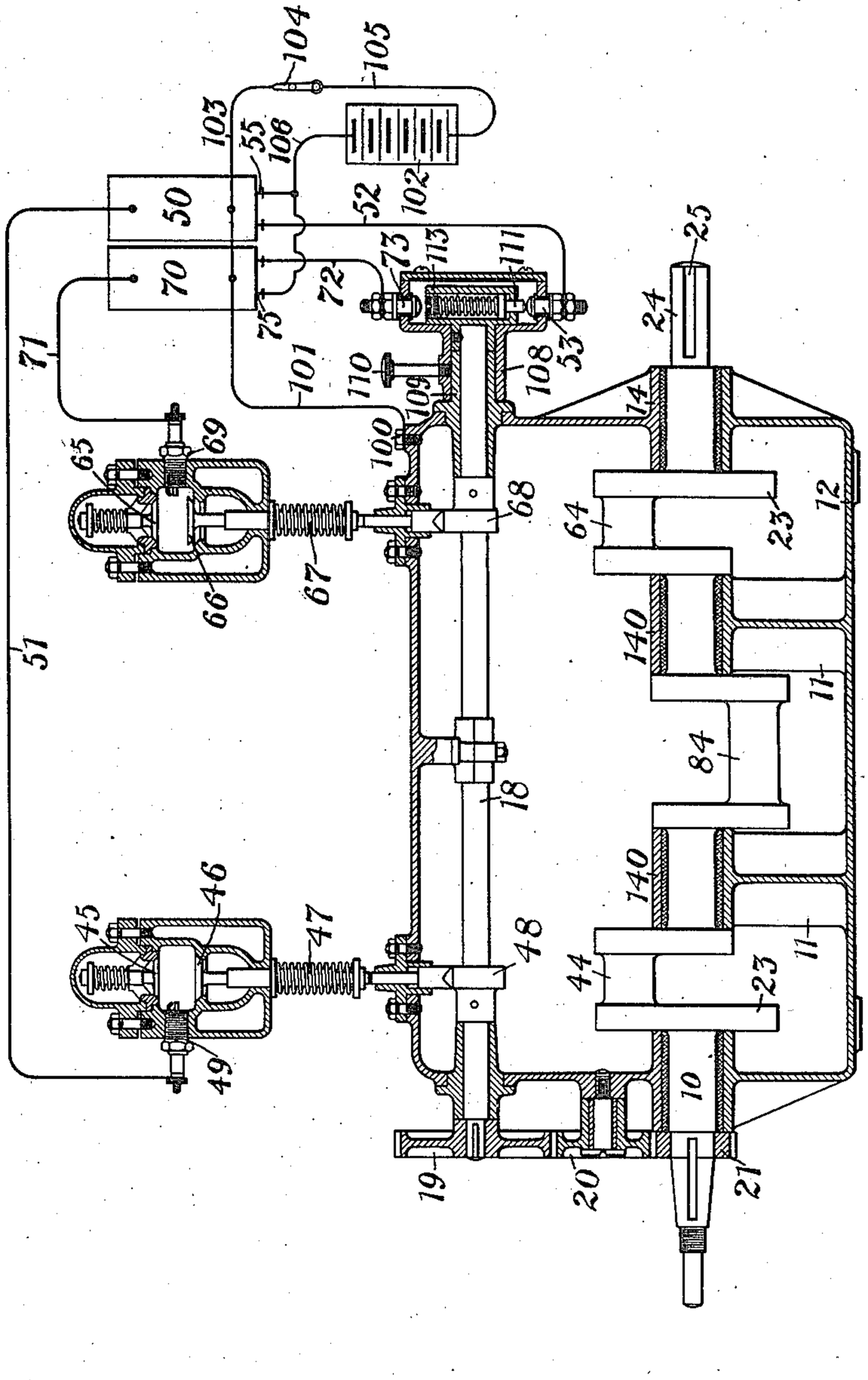
5 SHEETS—SHEET 5.

FIG. 5.



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UNITED STATES PATENT OFFICE.

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AIR-COMPRESSOR.

963,788. Specification of Letters Patent. Patented July 12, 1910.

Application filed March 16, 1907. Serial No. 362,644.

To all whom it may concern:

Be it known that I, FRANK H. MERRILL, a citizen of the United States, residing in Plainfield, in the county of Union and State of New Jersey, have invented certain new and useful Improvements in Air-Compressors, of which the following is a specification.

This invention relates to direct-connected four-cycle gas engine actuated air compressors.

The object of this invention is to provide means whereby an air compressor may be actuated by four-cycle gas engines and in such a manner that for each excursion of the compression piston or each compression stroke thereof there will be a driving impulse from the engine; in other words, an explosion will be produced to exert its driving power on the crank-shaft each time work is applied to it from the compressor. To accomplish this a pair of four cycle engines are coupled up to the crank shaft of the compressor and the explosions are so timed that there will be an explosion to each rotation of the shaft, the explosions taking place alternately in the cylinders. The explosions will take place at such times that the expansive force of each explosion will give a working impulse to the crank shaft at the time the compressor piston is making its working stroke or outward excursion.

In the use of a single four cycle engine, that is one cylinder and piston, for driving an air compressor, it has been found that an undue amount of vibration is produced owing to the fact that the parts are not evenly balanced, and also to the further fact that during the supply or suction stroke of the engine piston the fly wheel and other parts must have momentum enough to carry the air compressor piston to the full extent of its working stroke. The compressor piston will make two working strokes to one working stroke of the engine piston. The vibration of such engines has been so great as to preclude the construction of the same in a portable form; they have had to be built upon heavy foundations; but by my present improvement it will be feasible to construct a device in portable form owing to the fact that the vibration is minimized.

The piston, pitman and the connections of the compressor may be made double the weight of the piston, pitman and connections for each of the engines, that is, the combined weight of the pistons of the engines and the parts which connect these to the cranks will be equal to the weight of the piston of the compressor and the parts which connect it to the crank, so that the mechanism will be evenly balanced.

In the drawings accompanying and forming a part of this specification Figure 1 is a side elevation of a practicable embodiment of a form of my present improvement. Fig. 2 is a longitudinal section of the device illustrated in Fig. 1. Fig. 3 is a cross section through the compressor taken on a plane in about the line 3—3 of Fig. 2. Fig. 4 is a cross section of one of the engines taken on a plane in about the line 4—4 of Fig. 2; and Fig. 5 shows the lower portion of the crank case in section on the same plane illustrated in Fig. 1 and the upper portion of the crank case at a plane forward of such plane and in the plane of the valve stems and the cam shaft for actuating these; many of the parts are not shown in this view since it is intended as a diagrammatic view for illustrating the electrical circuits for the spark plugs together with a form of commutator for closing the circuits in proper timing.

The crank shaft, designated by 10, is shown supported by a number of bearings 11 carried by the framing member 12, which framing member constitutes the lower portion of the crank casing. This framing member 12 may be mounted upon a sub-base 13 when it is desired to use the structure as a stationary device. The caps 14 of the end bearings for the crank shaft are carried by the upper framing member 15 which constitutes the upper portion of the crank case, and the caps 140 for the intermediate bearings are free from the casing. Two four cycle gas engine cylinders 40 and 60 are shown mounted upon the framing and opening at their back ends into the crank casing. Pistons 41 and 61 are mounted within the respective cylinders and carry pins 42—62 connected by pitmen 43—63 with crank pins 44—64 upon the crank shaft 10. The supply for each of these cylinders is drawn in through a valve 45—65, receiving supply from supply pipes, designated without preference by 16, and exhausting through pipes, designated without preference by 17. The

exhaust from the respective cylinders will be through valves 46—66, the valve stems 47—67 being controlled by cams 48—68 upon a cam shaft 18, which cam shaft has a gear wheel 19 meshing with an idler 20 which engages a pinion 21 fast with the crank shaft and with the fly wheel 22 which is carried by the crank shaft. This gearing is two to one. The compression cylinder 80 is shown in the present instance mounted upon the framing and opening into the crank case and situated between the cylinders 40 and 60. Its piston 81 carries a pin 82 pivoted to the pitman 83 which is articulated to the wrist pin 84 upon the crank shaft 10. It will be seen that the piston, pitman and crank pin for the compressor are heavier than those for the engine cylinders. This is for providing equal weight so that the combined weight of these parts of the engines will equal the weight of the similar parts connected with the compressor. This is for the purpose of balancing. The crank pins 44—64 are shown upon one side of the shaft and the crank pin 84 is in the present instance disposed diametrically opposite upon the other side. The crank shaft 10 adjacent to the cranks carrying the wrists 44—64 is shown as carrying projections 23 projecting toward the side carrying the crank pin 84 for the purpose of bringing as much weight upon one side of the crank shaft as there is upon the other side. The two engine cranks will balance these projections and the compressor crank. It will thus be seen that the structure is mechanically balanced by having the various parts properly proportioned; it is balanced as to power by having the parts made so that an explosion occurs for each working stroke of the compressor, and it is also balanced as to power and to structure by having the compressor located between two power cylinders.

The engine cylinders are provided with sparking devices 49—69 respectively, and each of these is connected up with a spark coil 50—70 by circuit wires 51—71, both of which are grounded on the frame at 100 by a common wire 101 in the circuits 51—71. The current for the primary circuit is shown as being derived from a battery 102 which is grounded at 100 by being connected to the wire 101 by means of a wire 103, switch 104 and wire 105 at one end and the other end having a wire 106 which is connected to the primary coils of the spark coils by means of wires 55—75. The other terminals of the primary coils are led out by wires 72—52 and are connected to contact devices 73—53 of a commutator, the casing 107 of which commutator has a hub 108 mounted upon an extension 109 of the bearing for the shaft 18. Adjustment of this casing for adjusting the timing of the sparking may be effected by rotating the casing, and a set screw 110 is provided for fastening it in its adjusted position. The contacting member 11 of the commutator is carried by a frame 113 secured to the shaft 18. Since the gearing between the shaft 18 and the crank shaft is one to two the primary circuit of each of the spark coils will be closed at each second rotation of the crank shaft, and at each rotation of the crank shaft one or the other of the circuits will be closed. In the positions illustrated the primary circuit for the spark coil 50 is closed and this primary circuit may be traced as follows: circuit closer contact 111, contact 53, wire 52, the primary coil, not illustrated, for the sparking coil 50, wire 55, wire 106, battery 102, wire 105, switch 104, wires 103 and 101 to the casing at 100, shaft 18, frame 113. At different times in the running of a gas engine the sparking will take place at different periods of the piston movement and at different times relative to the exhaust valve action. In the illustration in Fig. 5 the crank pin 44 is shown on its dead center, the supply valve is shown as closed and the sparking device in operation, so that the primary coil having been closed in the manner described the secondary circuit will carry the high tension current from the sparking coil 50 by means of the wire 51 to the spark plug 49, causing a spark to jump from one point to the other of said sparking plug and ground on the casing of the engine unit and find its way by the various parts to the point 100 and then return by the wire 101 to the sparking coil 50. The exhaust valve 66 communicating with the cylinder 60 is in this illustration shown as open; it, however, will be permitted to close at the proper time and the sparking to take place at the spark plug 69 at the proper time for this. Since the circuits are substantially the same for both spark plugs it will be unnecessary to describe the same in detail for each. By this means one of the engine pistons, as 41, will have an expansive impulse given to it during the time that the other, as 61, is drawing in its supply of gas which supply when compressed will be exploded and the expansive force of the explosion will be communicated to the wrist pin 64 on the crank shaft while the other piston, as 41, is drawing in its supply.

The air for supplying the compressor may be brought to it through a pipe 85 entering, in the present instance, the lower portion of a chamber 86, the upper portion of which chamber 86 communicates by means of a port 87 with the cylinder 80, and which port is controlled by a back pressure valve 88, the stem 89 of which is carried by a hub 90, a suitable spring and adjustable check nut being employed for holding this to its seat. A set screw 91 is shown in axial alinement with the valve

stem 89 and a lock nut 92 is provided for locking this set screw in position. By this means the valve 88 may be held from its seat when it is desired to run the engines for power and cut out the air compressing feature. The end of the crank shaft is shown as projecting at 24 and provided with a keyway 25 to which a pulley or some other power transmission device may be attached. This is particularly useful when the apparatus is used for construction or repair work, as for instance it may be desired to use the compressor for supplying the power for pneumatic riveters, and it may at times be necessary to use the engine for performing other work on the job, so that all it will be required to do when it is desired to cut out the compression feature and use the engine for supplying power, will be to adjust this screw and hold the back pressure valve from its seat.

Since this device will be run by a four cycle engine the compressor piston will move rapidly and in the rapid movement of a compressor piston it sometimes happens that the cylinder does not completely fill with air in its movement, and to avoid this detraction of the efficiency of the device a port 93 from the supply chamber 86 is provided, so that it will be uncovered by the piston 81 in its extreme downward stroke or its recession movement. This, of course, will permit the cylinder to fill and upon the inauguration of the upward stroke of the piston the port will be closed and the compressed charge will be forced out through a valve, designated in a general way by 94, from which the compressed charge will pass through a pipe 95 to some convenient point of storage or utilization. The back pressure supply valve and the back pressure valve through which the compressed charge is forced form no part of my present improvement, and, therefore, will not be described in detail since the form illustrated is now well known in the art.

At times it may be desired to compress a smaller amount of air than the full capacity of the cylinder, but with a higher degree of compression, without increasing the power which is driving the compressor. For this purpose a port 96 is provided between the limits of stroke of the compression piston which is normally closed by a valve 97 controlled by a screw 98 and hand wheel 99. If now it is desired to decrease the amount of air delivered, either for the purpose of having that which is delivered under a higher state of compression, or if it is desired to take off some of the power from the engine in another form, this port will be opened and the first portion of the working excursion of the piston will necessarily be rendered idle, the second portion will be compressing. If the engine has not had other work thrown upon it the momentum acquired by the parts while the compressor is idle will be utilized with the working force that is still being expended upon the crank shaft and together a higher compression will be put upon the smaller charge of air within the cylinder 80.

The cylinders of the engines and the compressor are shown as provided with water jacket chambers, designated without preference by 26.

The operation of the present apparatus will be substantially as follows when constructed generally along the lines indicated in the present illustration: It may be assumed, having reference to Fig. 2 and also to the representation of the electrical devices, that the explosive mixture has been compressed in the cylinder 40 and exploded and that the piston 41 is moving downward responsive to the expansion following such explosion and that the driving impulse thereof is being imparted to the crank shaft 10 through the wrist pin 44 and that the wrist pin 84 will be raised by the crank shaft 10, which will force the piston 81 into the cylinder 80 thereby first closing the port 93 and forcing the charge of air, when this has been compressed to a certain amount, past the back pressure valve 94 and into the service pipe 95. And while the piston 41 is moving downward responsive to the expansion following the explosion the piston 61 will also be moving downward but will be drawing in a supply of explosive mixture, generally gas and air, which upon the movement of the crank shaft, which will bring down the piston 81 to draw in its supply of air, both engine pistons will be moving idly up, the engine piston 41 for expelling the products of combustion and scavenging the cylinder 40 and the piston 61 for compressing its supply of explosive mixture preparatory to the explosion thereof.

By the means just described it is possible to employ in connection with an air compressor gas engines of the four cycle type and to have an explosion exert its force upon the compressor at each compression stroke thereof which will afford even running and balancing of the apparatus and avoid much vibration which takes place when but one four cycle engine cylinder is employed for driving a compressor which is coupled to it in such a manner that two compression strokes take place at each explosion.

Having described my invention I claim:

1. In an air compressor, the combination with a crank shaft, of a compressor cylinder, a piston in the compressor cylinder directly connected to one side of the crank shaft, a pair of four-cycle gas-engine cylinders situated upon opposite sides of said compressor piston, pistons in said gas engine cylinders

directly connected to the other side of said crank shaft, and means for alternately effecting explosions in said engine cylinders.

2. In an air compressor, the combination with a crank shaft, of a compressor cylinder, a piston in the compressor cylinder directly connected to one side of the crank shaft, a pair of four-cycle gas-engine cylinders situated upon opposite sides of said compressor piston, pistons in said gas engine cylinders directly connected to the other side of said crank shaft, spark devices in said engine cylinders, and commutators for alternately effecting explosions in said cylinders.

3. The combination with a pair of power pistons, of a driven piston, a crank shaft, two cranks and crank wrists on one side of the shaft for the power pistons, and balancing extensions and a crank and wrist for the driven piston on the other side of the shaft, the two cranks and the one crank and extensions being substantially equal in weight, pitmen connecting the respective pistons to the crank wrists, the crank wrist for the driven piston being double the weight of the wrists for the power pistons, and the weight of the driven piston and pitman being double the weight of each of the power pistons and pitmen.

4. The combination with a pair of power pistons, of a driven piston located between these and having a weight equal to their combined weight, a crank shaft, two cranks and crank wrists on one side of the shaft for the power pistons, and a balancing extension from each of said cranks and a crank and wrist for the driven piston on the other side of the shaft, the two cranks and wrists and the one crank, wrist and extensions being substantially equal in weight, pitmen connecting the respective pistons to the crank wrists, the weight of the driven pitman being equal to the combined weight of the power pitmen.

5. The combination in an air compressor, of a compressor piston, a crank shaft having a crank upon one side, a pitman connecting this crank to the piston, a pair of gas-engine cylinders located upon respective sides of said compressor piston, a pair of cranks upon the other side of said crank shaft, pitmen connecting these cranks respectively to the engine pistons, each of said engine pistons and pitmen being substantially half the weight of the compressor piston and pitman.

6. In an air compressor, the combination with a cylinder and a piston therein, of a supply chamber, a supply port at the head of the cylinder and in communication with the supply chamber, a back pressure valve controlling the said port, a port in the cylinder positioned to be normally covered by the piston and to be uncovered by the piston at its extreme outward stroke, and an escape valve opening into the said supply chamber for reducing the efficient length of the cylinder.

Signed at Nos. 9–15 Murray street, New York, N. Y., this 13th day of March, 1907.

FRANK HEATH MERRILL.

Witnesses:

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FRED. J. DOLE.