Aug. 14, 1945. H. A. ANDRESEN 2,382,598

COMPRESSOR

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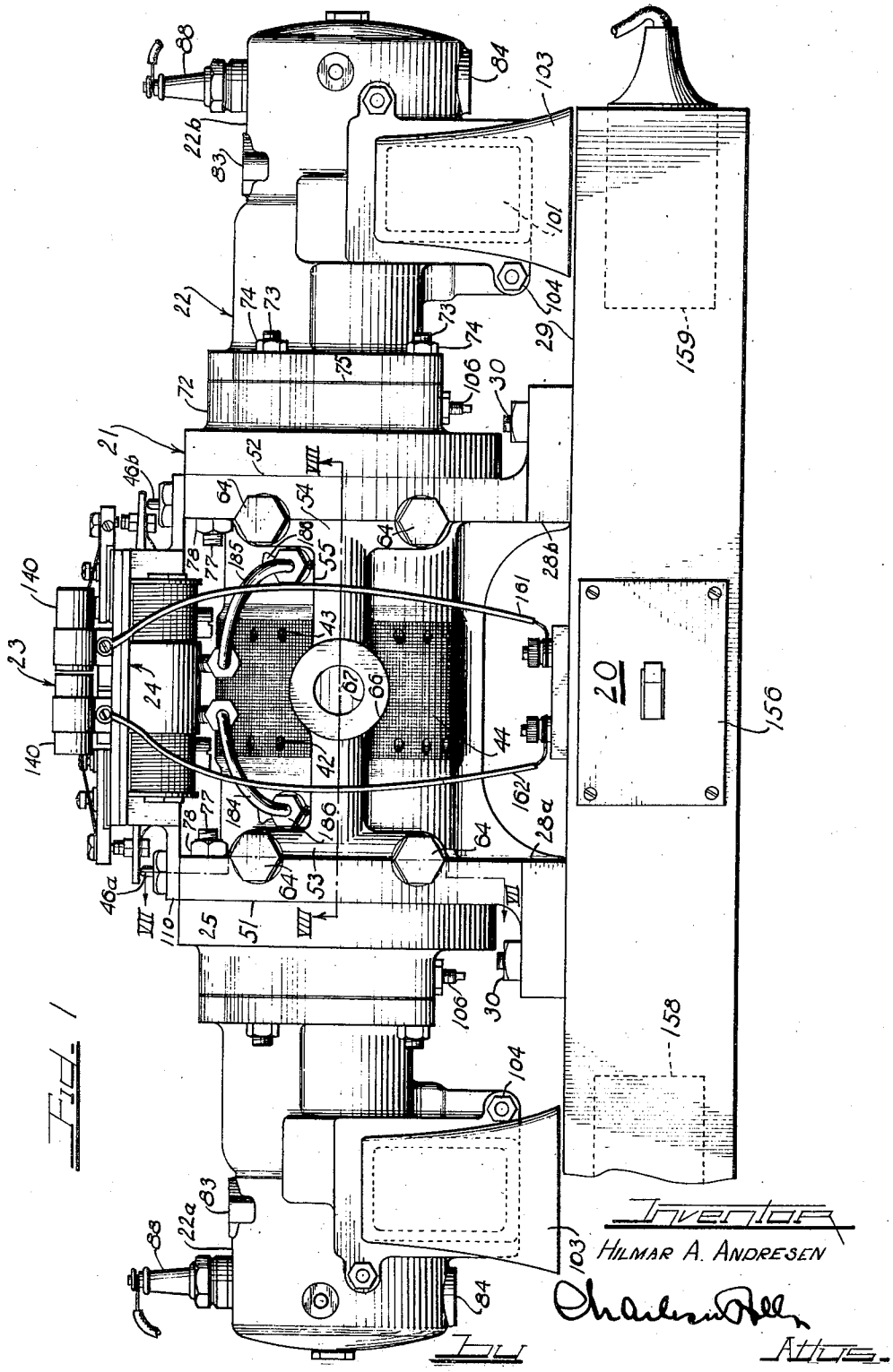


Fig. 1

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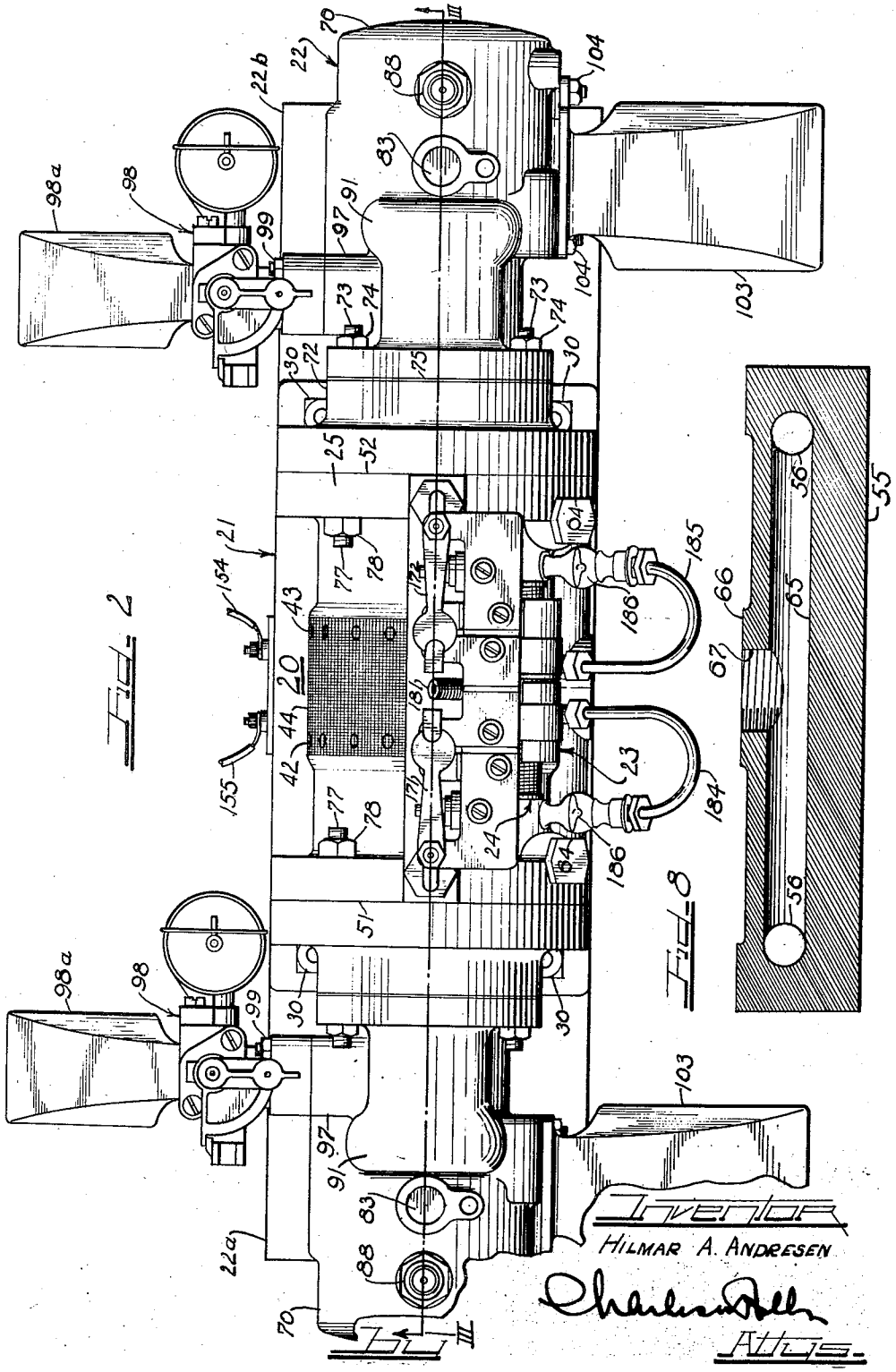
By

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COMPRESSOR

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COMPRESSOR

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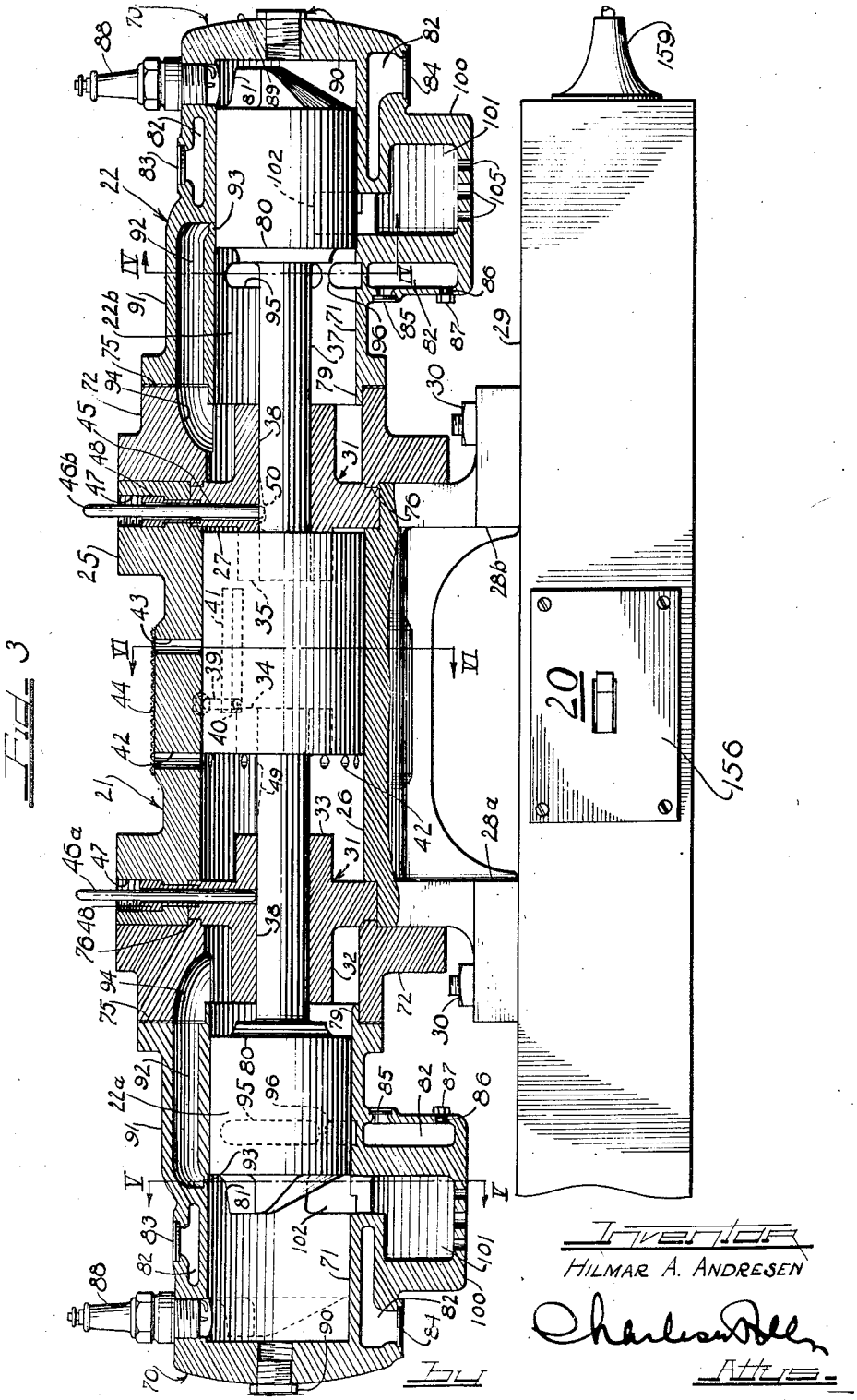


Fig. 3

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COMPRESSOR

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Fig. 7

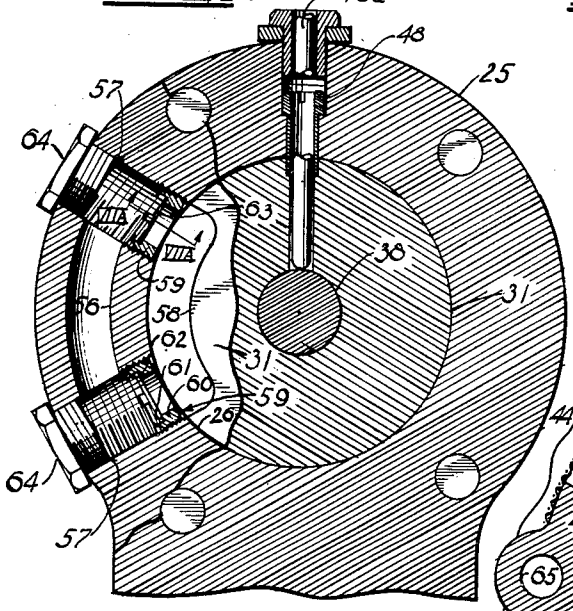


Fig. 7a

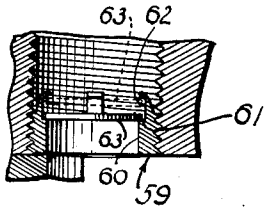


Fig. 6

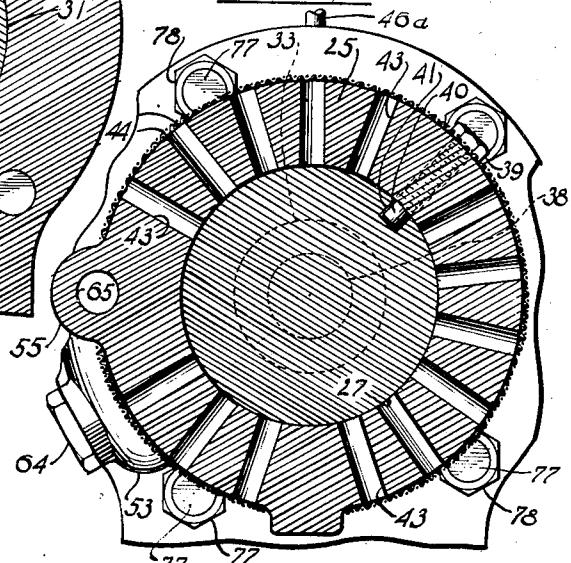


Fig. 5

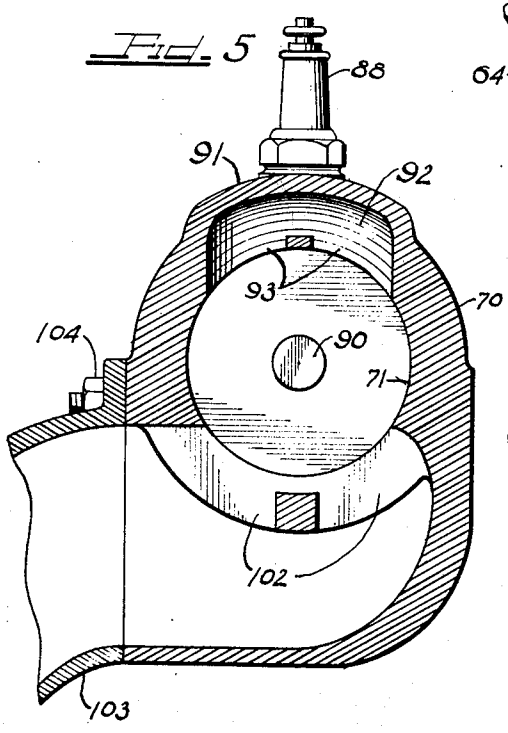
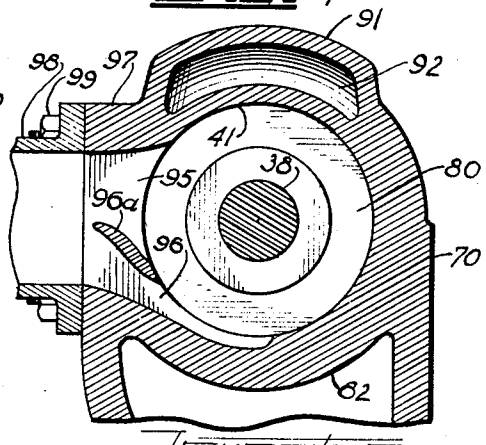


Fig. 4



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COMPRESSOR

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Fig. 9

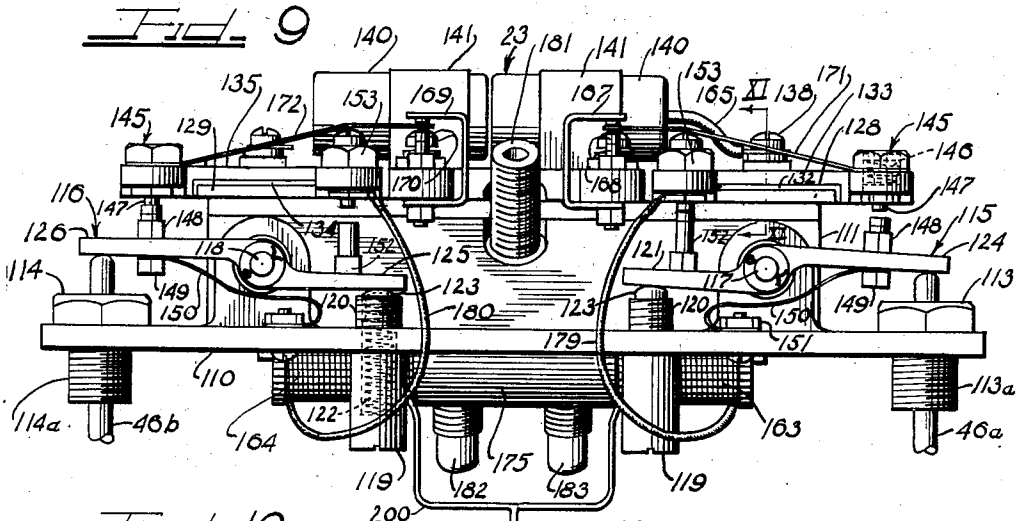


Fig. 10

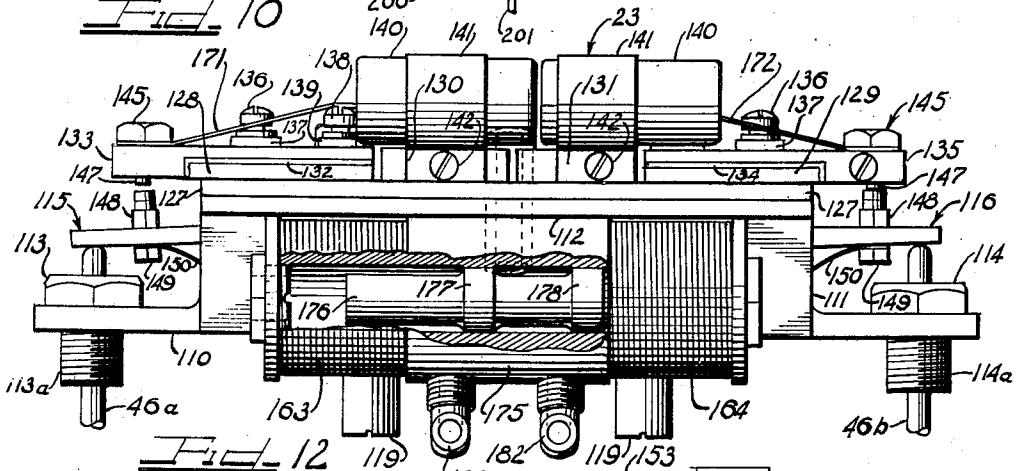


Fig. 12

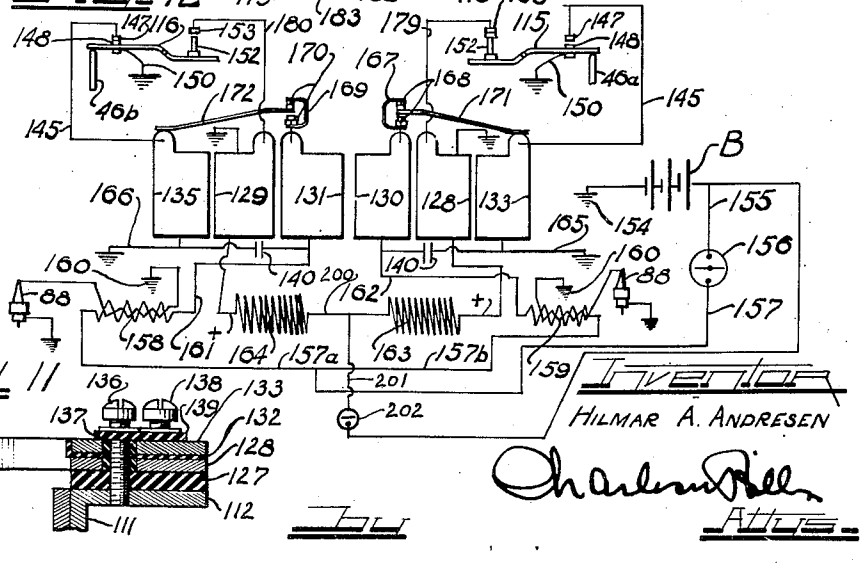


Fig. 11

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Patented Aug. 14, 1945 2,382,598

UNITED STATES PATENT OFFICE

2,382,598

COMPRESSOR

Hilmar A. Andresen, Chicago, Ill., assignor of one-half to Melville Keim, Chicago, Ill.

Application September 25, 1941, Serial No. 412,243

9 Claims. (Cl. 230—56)

The present invention relates to compressors and more particularly to certain improvements in construction and operation of a combined air-compressor and internal combustion engine.

In the usual air-compressor construction, one or more compressor pistons are reciprocated by a mechanism whose stroke is mechanically limited for maintaining each compressor piston in spaced relation from the end walls of the cylinder within which it slides for compressing air or other fluid. As compared with the present invention, the usual compressor construction employs a greater number of relatively movable parts which make for a heavy and cumbersome device. Furthermore, the increased friction of additional parts effects a proportionate reduction in the efficiency of the mechanism.

The present invention seeks to provide an engine-compressor in which the pistons thereof are fixedly connected together and each freely slidable axially within separate cylinders. Combustion and compression pressures are so arranged and timed as to limit the stroke of the pistons. Consequently, the speed of operation is high and is limited only by the operative pressures developed and the time required in overcoming the kinetic energy of the pistons by the compression pressures against which the pistons work.

It is, therefore, an object of the present invention to provide an improved compressor of extremely simple and durable construction.

Another object of this invention is to provide a high speed compressor whose working stroke is limited by the operative pressures developed for actuating the compressor.

A further object of the present invention is to provide a combined engine and compressor of the reciprocating piston type with the working stroke of the compressor being limited only by balancing of the kinetic energy and the compression pressures of fluid as the pistons are reciprocated.

A still further object of the present invention is the provision of a combined internal combustion engine and fluid compressor construction in which the kinetic energy of reciprocating pistons resulting from pressures of combustion exerted in one direction is balanced by the compression pressures of fluid exerted in the opposite direction for limiting the stroke of the pistons.

Another and still further object of this invention is the provision of an improved ignition system for effecting combustion within an engine for actuating a compressor.

A still further object of the present invention is the provision of an ignition system for an engine-compressor construction which is controlled either manually or by the reciprocation of piston rods therein.

A further object of the present invention is the provision of a two-cycle engine of the reciprocating piston type having a compressor between the reciprocating pistons for compressing fluids.

Another and further object of this invention is the provision of a novel starter mechanism for an internal combustion engine.

Still another object of this invention is the provision of an engine having spaced reciprocating pistons connected to a compressor piston therebetween with a starter mechanism for supplying fluid under pressure to the compressor piston for reciprocating the latter and the connected engine pistons.

A still further object of the present invention is the provision of an engine-compressor construction having pistons connected by piston rods which cooperate with ports for controlling the intake and exhaust of fluids therethrough and which cooperate with an electrical system for timing the ignition of fuel in the engine as the pistons and rods reciprocate.

The novel features believed to be characteristic of the present invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and manner of construction, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings, in which:

Figure 1 is a side elevational view of the compressor construction of the present invention;

Figure 2 is a top plan view of the compressor construction of the present invention;

Figure 3 is a vertical cross-sectional view, with parts in elevation, and other parts omitted, taken along the line III—III of the compressor illustrated in Fig. 2;

Figure 4 is an enlarged fragmentary vertical cross-sectional view, with parts in elevation, taken substantially along the line IV—IV of Fig. 3;

Figure 5 is an enlarged fragmentary vertical cross-sectional view, with parts in elevation, taken substantially along the line V—V of Fig. 3;

Figure 6 is a view similar to Figs. 4 and 5 taken substantially in the plane indicated by the line VI—VI of Fig. 3;

Figure 7 is an enlarged fragmentary view, with parts in elevation, as seen when taken substantially in the offset planes indicated by the line

VII—VII of Fig. 1 and looking in the direction of the arrows;

Figure 7a is a cross sectional view taken along the line VIIA—VIIA of Fig. 7 illustrating a check valve;

Figure 8 is an enlarged horizontal cross-sectional view through a sidewall of the compressor as seen when taken substantially in the plane indicated by the line VIII—VIII of Fig. 1;

Figure 9 is a side view in elevation of the ignition and starter control mechanism;

Figure 10 is a view similar to Fig. 9 as seen on the opposite side and illustrating, in a cut-away portion, the internal mechanism of the starter control;

Figure 11 is a fragmentary vertical cross-sectional view taken substantially along the plane indicated by the line XI—XI of Fig. 9 and illustrating the manner of insulating parts of the ignition control mechanism; and,

Figure 12 is a wiring diagram illustrating the electrical system of the compressor device of this invention.

As best shown in Figs. 1, 2 and 3, the compressor construction 20 of this invention generally comprises a compressor 21, a two-cycle internal combustion engine 22 for actuating the compressor, an ignition system control mechanism 23 and a starter mechanism 24 for initially reciprocating the pistons of the compressor construction.

For convenience, each of the above mentioned mechanisms will be described under a separate heading.

The compressor

The compressor 21 has a cylinder casting 25 which is internally bored as at 26 for slidably receiving therein a piston or plunger 27. Integral legs 28a and 28b are suitably apertured for mounting the cylinder 25 on a base 29 by means of stud and nut assemblies 30.

The ends of the cylinder 25 are provided with enlarged bores for respectively receiving therein the end closure members 31. Each end closure member 31 has an outwardly extending hub 32, for a purpose to be more fully explained hereinafter, and an inwardly extending hub 33. The ends of the piston 27 are suitably recessed as at 34 and 35 for loosely receiving therein the inwardly extending hubs 33 as the piston nears the end of its stroke. The fit between the hubs 33 and the recesses 34 and 35 is such that fluid will not be trapped in the recesses but is compressed and forced out into the bore of the compressor cylinder.

Piston rods 36 and 37 are each suitably connected to an end of the piston 27 by threading, welding or other similar means. The piston rods extend axially away from the piston 27 and are slidingly received through bores 38 in the end closure members 31.

As best shown in Figs. 3 and 6, a stud 39 is threaded through a side wall of the cylinder 25 with its smooth inner end 40 seated in a longitudinal slot 41 extending intermediate the ends of the piston 27 at its periphery. The inner end 40 of the stud 39 permits the piston 27 to be reciprocated within the cylinder bore 26 but prevents rotation thereof.

Spaced annular rows of radially extending inlet openings 42 and 43 are provided through the side walls of the cylinder 25 (Figs. 1, 2, 3 and 6). The rows of inlet openings 42 and 43 are positioned to communicate with the chamber defined by the bore 26 at the ends of the piston stroke to permit air to flow into the chamber when the piston is at either end of its stroke. When the piston has been moved to the end of its stroke to the right, the inlet openings 42 permit air to flow into the cylinder at the left-hand end of the piston. When the piston has been moved to the end of its stroke to the left, the inlet openings 43 are uncovered to permit air to flow therethrough into the cylinder 26 adjacent the right-hand end of the piston. A screen 44 surrounds the cylinder 25 to cover the inlets to the rows of holes 42 and 43 for filtering the air flowing into the cylinder bore.

A vertical bore 45 is provided in each of the end closure members 31 between the hubs 32 and 33 for receiving therethrough the actuating rods 46a and 46b whose purpose is to be more fully explained hereinafter. The outer end of each bore 45 is enlarged and threaded as at 47 for receiving an externally threaded sleeve 48 provided with an internal bore slightly larger than the diameter of the actuating rod received therethrough. Each of the actuating rods is thus slidably mounted and the clearance therearound relative to a sleeve 48 is kept at a minimum in order that as little pressure as possible may seep thereby. As an aid in eliminating the seepage of pressure from the bore 26 around the actuating rods 46a and 46b, the inwardly extending hubs 33 are provided for effecting a longer bearing with a piston rod 38 and for seating in the piston ends.

When the piston 27 is reciprocated within the bore 26, vertical movement of the actuating rods 46a and 46b is provided by the tapered slots 49 and 50. Each of these slots extend in a longitudinal direction on the piston rods 38, 38 with their deep ends toward the piston.

As will be seen in Fig. 3, when the piston 27 has been moved to the right the actuating rod 46a engages the periphery of its adjacent piston rod 38 while the actuating rod 46b has moved downwardly into the deep end of the slot 50. As the piston 27 is moved to the left, the actuating rod 46b cams along the bottom of the slot 50 until it engages the periphery of the adjacent piston rod 38. When the piston nears the end of its stroke in a direction toward the left, the inner end of the actuating rod 46a will slide downwardly to the deep end of the slot 49.

As best shown in Figs. 1, 6, 7 and 8, the ends of the cylinder 25 are provided with radially extending peripheral flanges 51 and 52 for a purpose to be more fully apparent later. Rib portions 53 and 54, extending partially around the circumference of the cylinder 25, are positioned adjacent the flanges 51 and 52. A transversely extending rib 55 connects the ribs 53 and 54.

The flange 51 and rib 53 are cored to provide an arcuate recess 56. Radially extending internally threaded openings 57 are provided adjacent the ends of the arcuate recess 56 through the sidewall of the cylinder 25. The end closure member 31 has an arcuate slot 58 connecting the openings 57, 57 with the cylinder bore 26.

As shown in Figs. 7 and 7a an exteriorly threaded check valve 59 is threaded into the inner end of each of the openings 57. Each check valve includes an internally bored sleeve 60 countersunk at its upper end to form a shoulder 61. A plurality of upwardly extending inwardly flanged fingers 62 are provided in spaced relation circumferentially at the upper end of each

of the check valve members 59. These fingers serve to retain a valve plate 63 in connection with the check valve member 59. Each plate 63 is free for movement in a direction axially of the sleeve 60 between the limits defined by the shoulder 61 and the inturned flanges at the ends of the fingers 62. It will be apparent that when the plate 63 seats on the shoulder 61 the internal bore through the sleeve 60 is closed against fluid flow. The operation of the check valves 59 will be more fully explained with the operation of the compressor construction.

Externally threaded plugs 64 are threaded into the outer end of each of the openings 57 to block the flow of fluid into the atmosphere.

The flange 52 and rib 54 on the opposite end of the cylinder 25 have the same construction as just described for the flange 51 and rib 53.

As shown in Fig. 8, the transversely extending rib 55 is internally cored to provide the recess 65 which terminates at its ends in the arcuate recesses 56, 56. A boss 66 is formed substantially at the center of the rib 55 and is provided with an internally threaded bore 67 communicating with the recess 65.

It will be apparent from the foregoing that the openings 67, 65, 56 and the opening through each of the check valves 59 provide passageway for exhausting fluid from each end of the cylinder bore 26 to the exterior of the cylinder 25. Suitable pipe fittings and fluid conducting pipes are connected to the internally threaded bore 67 and a fluid pressure tank (not shown) for receiving therein fluid such as air which is compressed by the piston 27 in the bore 26.

The actuating mechanism for reciprocating the compressor piston 27 will now be described.

Internal combustion engine

The internal combustion engine 22 is of the two-cycle type having separate but identical constructions at each end of the compressor 21. The engine portion at the left is identified by the reference numeral 22*a* and the engine portion at the right is identified by the reference numeral 22*b* only for convenience in describing the operation of the compressor construction. As the engine portions 22*a* and 22*b* are identical, only one will be described and the parts of each will be identified by like reference numerals.

Each engine portion has a cylinder casting 70 internally bored as at 71 and which is connected to a spacer member 72 by means of circumferentially spaced studs 73 and nuts 74. A gasket 75 is inserted between the cylinder casting 70 and the spacer member 72 for providing a fluid-tight joint therebetween.

The face of the spacer member 72 opposite the face in connection with the cylinder casting 70 is provided with an outwardly extending circumferential ring portion 76 which seats within a complemental groove formed in the end closure member 31. This interengagement provides a fluid-tight joint when the spacer member 72 is connected to the compressor cylinder 25 by means of studs 77 and nuts 78.

It will be noted that the free end of engine cylinder 70 has a portion 79 of reduced diameter for insertion into the bore of the spacer member 72. This interengagement is such as to axially align the engine bore 71 with the compressor bore 26.

A piston 80 is slidable within the bore 71 and is connected to the outer end of the piston rod 38 by threading, welding or other suitable and similar means. The outer end of the piston 80 has a deflector portion 81 thereon for a purpose to be more apparent in the following description.

The cylinder 70 is water jacketed by the water chamber 82. Thin relief plugs 83, 84 and 85 are provided at the periphery of the cylinder 70 should the pressure of the water in the jackets exceed a predetermined degree through freezing or the like. A drain opening 86 extends through a wall of the cylinder 70 through which the cooling medium may be drained. This drain opening is normally closed by a cap screw 87.

An internally threaded opening is provided radially through a sidewall of the cylinder 70 adjacent the blind end thereof for receiving a spark plug 88. It will be noted that a similar internally threaded opening has been provided axially through the end wall 89 of the cylinder which is normally closed by a plug 90. If desired, the spark plug 88 may be substituted for the plug 90 to fire in an axial rather than a radial direction as illustrated.

The engine cylinder 70 has an upwardly extending thickened portion 91 which is internally chambered with an arcuate recess 92 (Figure 5). One end of the arcuate chamber 92 opens at 93 into an intermediate portion of the bore 71 while the opposite end thereof registers with a curved recess 94 provided diagonally outward in the spacer member 72. The recesses 92 and 94 connect an intermediate portion of the bore 71 with the end of the cylinder defined between the inner periphery of the spacer member 72 and the hub 32.

Circumferentially spaced inlet openings 95 and 96 separated by a baffle 96*a* join the bore 71 with the interior of a cored boss 97. A carburetor 98 for vaporizing liquid fuel and mixing it with air supplied through a hood 98*a* is connected to the boss 97 by means of a stud and nut assembly 99. The carburetor is connected to a source of fuel supply (not shown) in a well-known manner.

The cylinder 70 is also provided with an enlarged chambered portion 100 on its periphery for providing an enlarged exhaust opening 101 in connection with an opening 102 in the sidewall of the cylinder 70. These openings permit exhausting of combustion gases from the bore of the cylinder 70 to the atmosphere.

If the combustion gases are to be exhausted adjacent the base 29, a hood member 103 is detachably secured by a stud and nut assembly 104. Combustion gases exhausted through the openings 101 and 102 are thereby exhausted away from the base 29. A modified form of exhaust means is illustrated in Fig. 3 wherein a plurality of openings 105 may be provided in the bottom wall of the chamber 100 and the exhaust gases may flow therethrough with a muffling effect directly into the atmosphere or into an exhaust line connected thereto (not shown). When so used, the opening 101 is plugged.

It will be apparent from the foregoing description that reciprocation of the engine pistons 80, 80 will reciprocate the compressor piston 27. With the parts positioned as illustrated in Fig. 3, the vacuum created in the end of the compressor bore 26 by movement of the piston 27 to the right will cause air to flow from the atmosphere through the inlet openings 42 into the compressor cylinder. Likewise, the movement of the engine piston 80 at the end 22*b* in a direction toward the right, will result in the inlet openings 95 and 96 being unmasked for the flow

of mixed fuel into the cylinder bore 71. Compressed fuel is trapped between the piston 80 and cylinder end wall 89 which is ignited through the spark plug 88 to drive the piston in a direction toward the left. When the right-hand piston 80 is forced to the left, the compressor piston 27 compresses air trapped in the bore 26. When the pressure of the compressed air is higher than the pressure on the opposite side of the check valve plate 63 the latter will open to permit the air under pressure to flow through the openings 57, 56, 65 and 67 where it will enter a pressure tank (not shown). During this movement, the left-hand piston 80 compresses the fuel charge which flows from the rear of the cylinder through the registered recesses 92 and 94 to a position ahead of the piston. As the left-hand piston 80 travels forwardly it masks the fuel inlet openings 93, 95 and 96.

The weight of the pistons 80, 80 is such that kinetic energy will continue the axial movement of the compressor piston 27 to fully compress the trapped air therein even though the combustion pressure on the "live" piston has been practically spent as the latter piston reaches the end of its stroke and the opposite piston is compressing a charge of fuel thereahead.

An ignition mechanism, to be shortly described, regulates the sparking of the spark plugs 88, 88 so that ignition of a charge of fuel is timed to take place at approximately a point in which the compressing piston has traveled three-quarters of its full stroke toward full compression. The speed of the compressor construction is such that the remaining one-quarter stroke of the piston is necessary to effect maximum combustion pressure to be exerted against the piston to force it away from the cylinder end wall 89. In other words, compression takes place for approximately one-quarter of the piston stroke after the fuel has been ignited.

Compression of the fuel charge by one of the engine pistons and compression of the air by the compressor piston 27 eventually expends all of the kinetic energy to bring the rigidly connected pistons to a stop. The compression and combustion then reverses the movement of the pistons in the opposite direction.

It will be apparent from the foregoing, that the stroke of the pistons 27 and 80, 80 is limited only by expending the kinetic energy built up by motion of the pistons in one direction in compressing a charge of fuel and trapped air in the compressor at the ends of one of the pistons 80 and the piston 27 opposite to the end of the other piston 80 against which combustion pressures are exerted.

As the pistons 80, 80 reciprocate in the bores 71, 71 they mask and unmask the fuel inlet openings 95 and 96. During movement of each engine piston inwardly, the indrawn fuel is forced into the registered recesses 92 and 94. When the engine piston reaches the end of its stroke at the end of the cylinder 70, the compressed fuel in the recesses 92 and 94 flow into the bore 71 ahead of the piston through the opening 93. Reverse movement of the piston then compresses the trapped fuel ahead of the piston where it is ignited to form pressure by combustion. Likewise, each engine piston 80 masks and unmasks the exhaust opening 102 for the flow of spent gases to the atmosphere.

The deflector end 81 on each of the engine pistons 80 effects a scavenging of each of the cylinders 70. It will be noted that the exhaust openings 102 are large enough to extend forwardly of the fuel inlet openings 93 so that the cylinders may begin exhausting before fresh fuel is supplied thereto. When the engine piston 80 reaches the inner end of its stroke the fresh fuel and air entering through the inlet openings 93 strikes the deflector 81 and is deflected toward the end wall 89. This deflection of the fresh fuel forces the spent gases through the exhaust openings 102 and 101 into the atmosphere. The exhaust opening 102 is sufficiently large to completely exhaust the spent gases before the engine piston 80 masks the opening to trap the fresh fuel for compression. The relative sizes of the fuel inlet opening 93 and the exhaust opening 102 are such as to balance the pressures within the cylinders during the high reciprocating speed of the pistons. Also, the relative sizes of the exhaust openings 101 and 102 must be such that the surge of the exhaust gases is synchronized with the speed of the engine pistons. This synchronization of the exhaust gases is effected by adjusting the exhaust openings 105, 105, in conjunction with the large opening 101, by means of a masking element (not shown) to control the effective opening areas thereof.

If desired, supercharging may be effected by leading a small amount of compressed air from opposite ends of the compressor cylinder 25 to the carburetor for vaporizing the fuel by a suitable conductor such as a pipe (not shown).

It may also be desirable to supercharge by compressing the mixed fluid fuel and air. For this purpose, a ball check valve 106 is threaded into an opening in a side wall of the spacer member 72. In this case a suitable container and reduction valve is connected to the ball check valve 106 by a suitable conductor (not shown). It is also apparent that similar results may be effected by using part of the exhaust gases for vaporizing the fuel as it is drawn into the cylinders.

The timing mechanism for the ignition system generally referred to in the description of the operation above will now be more fully explained.

Ignition system

The ignition control mechanism 23 is best illustrated in Figs. 1, 2, 9 and 10. A base plate 110, having a vertical flange 111 and a horizontal flange 112 at the top thereof extending laterally from the base 110, is connected to the compressor cylinder 25 by means of internally bored cap screw members 113 and 114. The exteriorly threaded shanks 113*a* and 114*a* thereof are received through suitable end openings in the base plate 110 and are threaded into the internally threaded portions 47 of the actuating rod bores 45. The internal bores on the cap screws 113 and 114 permit the actuating rods 46*a* and 46*b* to extend therethrough.

A pair of contactor rocker arms 115 and 116 are pivotally connected adjacent the ends of the flange 111 by means of pivot pins 117 and 118.

As the ignition control mechanism 23 is identical in construction on both ends thereof on opposite sides of its vertical center line, the mechanism of only one side will be described and like parts will be designated by the same reference numerals.

A hollow member 119 has an externally threaded end portion 120 threaded through a suitable opening in the base plate 110 and in alignment with the inner end 121 of the contactor rocker arm 115. A coil spring 122 is seated with the member 119 to urge a plunger 123 against the end 121 of the contactor rocker arm. The coil spring 122

and plunger 123 serve to rock the contactor rocker arm 115 whereby its outer end 124 is maintained in contact with the actuating rod 46a. The same construction engages the inner end 125 of the contactor rocker arm 116 and serves to maintain the outer end 126 thereof against the actuating rod 46b.

A sheet of suitable insulation 127 is positioned between the laterally extending horizontal flange 112 and separates connector plates 128, 129, 130 and 131. An additional sheet of insulating material 132 separates a connecting plate 133 from the connector plate 128. Likewise, a sheet of suitable insulating material 134 separates a connector plate 135 from the connector plate 129.

As best shown in Fig. 11, connector plates 128 and 133 with the interposed dielectric 132 are connected together to the flange 112 by means of a stud 136. A dielectric flanged sleeve 137 is inserted through the connector plates 128 and 133 and the interposed dielectric sheet 132 for receiving therethrough the stud 136. Similarly, another stud 138 received through a dielectric flanged sleeve 139 connects other portions of the connector plates 128 and 133 to the flange 112. The dielectrically separated plates 129 and 135 are connected to the flange 112 in the same manner.

Each of the connector plates 130 and 131 carry a condenser 140 by means of a sleeve clamp 141 and a stud 142.

The outer end of the connector plate 133 is suitably apertured to receive therethrough a contactor point assembly 145 which includes a compensating coil spring 146 therein for urging the contactor point 147 in a projected operative position. A contactor 148 is carried by the rocker arm 115 in alignment with the resiliently supported contact point 147. A nut 149 is threaded to one end of the contactor 148 to carry one end of a ground conductor 150, the other end of which is connected to the base plate 119 by means of a bolt and nut assembly 151.

The inner end 121 of the rocker arm 115 has a contactor 152 thereon in alignment with a contactor unit 153 carried by the connector plate 128.

The same arrangement of contactors is provided between the rocker arm 116 and the connector plates 129 and 135.

It will be apparent from Figs. 9 to 12 that when the actuating rod 46a is at its lowermost position, the actuating rod 46b is in its uppermost position. The spring pressed plunger 123 urges the contactor 152 on its inner end 121 into engagement with the contactor 153 while the contactor 148 on the outer end 124 has been moved out of engagement with the contactor 147. Likewise, when the spring pressed plunger 123 has been moved inwardly by the actuating rod 46b through the rocker arm 116, the contactor 152 on the inner end 125 of this rocker arm has been moved out of engagement with the contactor 153 while the contactor 148 has been moved into engagement with the contactor 147.

As shown in the wiring diagram of Fig. 12, a source of energy such as a battery B is grounded as at 154 on any suitable part of the metal compressor assembly. A conductor 155 connects the other terminal of the battery with a switch 156 which, as shown in Figs. 1 and 3 can conveniently be mounted on the base plate 29. A conductor 157 from the switch 156 has the branches 157a and 157b leading to spark coils 158 and 159 respectively. These spark coils can feasibly be located in the base plate 29 as shown in Fig. 1.

The secondary winding of each spark coil 158 and 159 has one end thereof grounded as at 160 and the other end thereof connected to a spark plug 88. As is customary, each spark plug 88 is grounded on the motor body as shown.

The other end of the primary winding of the spark coil 158 is connected through a conductor 161 with connector plate 131. The corresponding other end of the spark coil 159 is connected through a conductor 162 with the connector plate 130. The conductors 161 and 162 can each be connected to ground through the breaker points 147 and 148.

The connector plates 128 and 129 are connected respectively to solenoid coils 163 and 164.

The connector plates 133 and 130 are connected by a conductor 165 to ground through the circuit including the condenser 140. Likewise the connector plates 131 and 135 are connected by a conductor 166 to ground through the circuit including the other condenser 140.

The connector plate 130 carries a bracket 167 with spaced superimposed connector points 168. Likewise, the connector plate 131 carries a bracket 169 with spaced superimposed connector points 170. A spring leaf 171 is mounted on the connector plate 133 and extends between the points 168 of the bracket 167. Likewise, a second spring leaf 172 is carried by the plate 135 and extends between the points 170 of the bracket 169.

It will be noted that the conductors 145 join the connector plates 133 and 135 with the contact points 147 on the respective sides of the device to provide the customary "closed" ignition breaker circuits. Likewise, the connector points 153 are in circuit connection with the connector plates 128 and 129 by conductors 179 and 180, respectively, to provide intermittent contacts in the "open" solenoid breaker circuits. The ignition breaker circuits and the solenoid breaker circuits are thereby alternately opened and closed through movement of the rocker arms 115 and 116.

The conductor 200 between the solenoid coils 163 and 164 is in circuit connection with the battery B through a conductor 201 in which a switch 202 is provided to disconnect the solenoid coils from the source of energization. This switch is closed during starting of the compressor and is opened during operation of the device.

The respective spark plugs 88 of the engine are thus energized in proper timed relation by closing the circuit from the battery through the sparking coils 158 and 159 whenever the rocker arms 115 and 116 are actuated by the rods 46a and 46b to bring the points 148 in contact with the points 147.

The actuating rods are thus controlled by movement of the pistons and in turn control the sparking of the spark plugs so that the fuel and air mixture will be ignited when the piston is in a position about three-quarters of the full length of its stroke as described above.

The starting mechanism

As shown in Figs. 9 and 10 the solenoid coils 163 and 164 are wound around a cylinder 175 which houses a slidably mounted valve 176 having enlarged portions 177 and 178. The coils 163 and 164 are alternately energized to reciprocate the valve 176 by movement of the rocker arms 115 and 116 to alternately join the contact points 152 and 153 thereby closing a circuit through the connector plates 128 and 129 respectively to the coils. Conductors 179 and 180 join the contact points 153 with the connector plates 128 and 129 respectively.

The chamber provided by the cylinder 175 can receive compressed air through an inlet 181. This compressed air is alternately fed to opposite sides of the piston 27 through outlets 182 and 183 respectively joined through pipes 184 and 185 with manually operated valves 186 (Fig. 1) threaded in the housing 25.

When it is desired to start the engine compressed air is fed through the inlet 181 from storage in the compressed air tank which is supplied by the operating compression. The compressed air enters the chamber of the cylinder 175 and is then directed to either the outlet 182 or the outlet 183 depending upon the position of the valve portions 177 and 178 relative to the outlet port. The position of these valve portions is controlled by the solenoid coils 163 and 164 as explained above.

The compressed air will alternately flow to opposite sides of the piston 27 thereby reciprocating the engine pistons 80, 80 resulting in the drawing in of the fuel and air mixture to the combustion chambers. If the engine parts are relatively warm or at normal temperature starting should immediately follow by the manual manipulation of the spring leaves 171 and 172. When the spring leaves are actuated manually, the connector plates 130, 133 and 131, 135 are in circuit connection and the spark plugs 88, 88 are thereby energized. If the engine does not start in this manner, then the starting mechanism is turned off by closing the valves 186. With the engine pistons stationary and a full charge of fuel and air in the cylinders, the spring leaves 171 and 172 are manually actuated to ignite the charge thereby starting reciprocation of the entire device. Once the device is started, ignition is controlled automatically as previously explained.

Conclusion

From the foregoing it will be apparent that I have provided a simplified compressor construction in which the compressor piston and the engine actuating pistons are connected together for co-movement and the stroke thereof limited only by the operative pressures developed within the piston cylinders as the construction operates. I have also provided an ignition system which is automatically operable by the reciprocating pistons or may be operated manually when the device is initially started by injecting fluid under pressure to the compressor for starting the reciprocation of the pistons. Also, starting of the device may be effected by drawing a full charge of fuel and air into the engine cylinders and then igniting the charge against the stationary engine pistons by manual actuation of spring leaves.

It is also to be understood that I may provide a compressor-engine construction having pistons of sufficient size and weight for storing kinetic energy whereby the ignition system described is entirely disconnected and the fuel compressed under pressures sufficient for self-ignition such as in Diesel engines. Likewise, the combustion engine portions of the present invention may combine features of both the electrical ignition and true Diesel types in order to provide a semi-Diesel arrangement.

While a particular embodiment only of this invention has been illustrated, it will, of course, be understood that the invention should not be limited thereto, since many modifications may be made and, therefore, it is contemplated by the appended claims to cover all such modifications as fall within the true spirit and scope of the present invention.

I claim as my invention:

1. A compressor construction comprising a cylinder having inlet and exhaust ports, a piston in said cylinder arranged to open and close said ports as it reciprocates, an internal combustion engine at each end of said cylinder, a piston for each engine, a piston rod rigidly connecting each of said engine pistons with said first piston for free co-movement, the stroke of said pistons being controlled only by the pressures of compression and combustion in said engines.

2. A compressor construction comprising an internal combustion engine having spaced aligned cylinders, pistons in said cylinders, a compressor cylinder between said engine cylinders, a double-acting piston in said compressor cylinder, means rigidly connecting said pistons together for co-movement, fluid inlet and outlet ports in each cylinder controlled by the reciprocation of the pistons therein, said engine pistons alternately drawing fuel therein and compressing said drawn-in fuel, and means for igniting said fuel, the stroke of said pistons being limited only by expending the kinetic energy built up therein through combustion pressures on one of the engine pistons in compressing both the drawn-in fuel by the opposite engine piston and the drawn-in fluid by the compressor piston.

3. A compressor construction comprising an internal combustion engine having spaced aligned cylinders, pistons in said cylinders, a compressor cylinder between said engine cylinders, a double-acting piston in said compressor cylinder, piston rods rigidly connecting said pistons together for co-movement, fluid inlet and outlet ports in each cylinder arranged to be opened and closed successively by the reciprocation of the pistons thereover, said engine pistons alternately drawing fuel therein and compressing said drawn-in fuel, means for igniting said fuel, and means operable by the reciprocation of said piston rods for establishing electrical impulses through said ignition means, the stroke of said pistons being limited to less than the length of their respective cylinders only by expending the kinetic energy built up therein through combustion pressures on one of the engine pistons in compressing both the drawn-in fuel by the opposite engine piston and the drawn in fluid by the compressor piston.

4. A compressor construction comprising a compressor cylinder having inlet and outlet ports, a double-acting reciprocating piston in said cylinder opening and closing said ports during reciprocation thereof, a combustion cylinder at each end of and in alignment with said compressor cylinder and having fluid inlet and outlet ports therein, a reciprocating piston for each engine cylinder opening and closing said ports during reciprocation, a piston rod connecting each engine piston with said compressor piston, means permitting free axial movement of said pistons and restraining rotation thereof, said engine pistons alternately drawing fuel therein and compressing said drawn-in fuel, means for igniting said fuel in each engine cylinder, and means operable by said reciprocating piston rods for alternately establishing electrical impulses through said ignition means, the stroke of said pistons being limited to less than the length of their respective cylinders only by expending the kinetic energy built up therein through com-

bustion pressures on one of the engine pistons in compressing both the drawn in fuel by the opposite engine piston and the drawn-in fluid by the compressor piston.

5. In a compressor having piston rods for connecting reciprocating pistons in combustion chambers, ignition means for said combustion chambers including means for establishing electrical impulses comprising longitudinally extending slots in said piston rods angularly disposed relative to the longitudinal axis thereof, actuating rods engaging the periphery of the piston rods and said slots therein for movement toward and away from the axis of said piston rods, and means operable by said movements of the actuating rods for energizing said ignition means and alternately igniting the fuel in said combustion chambers.

6. In a compressor including a plunger, and a piston for driving said plunger, the improvement which comprises a rod directly connecting said plunger with said piston, said rod having a tapered slot therein, spring pressed means movable into and out of said slot as the rod oscillates, and fuel ignition means for driving said piston controlled by movement of said spring-pressed means whereby the position of said rod controls operation of said ignition means.

7. A compressor comprising a reciprocal plunger, piston rods extending longitudinally from said plunger, pistons on the ends of said rods, means defining combustion chambers receiving said pistons, said piston rods having tapered slots therein, actuating rods movable into and out of said slots, ignition means for said combustion chambers controlled by said actuating rods, and a compressed fluid starting mechanism for oscillating said pistons controlled by said actuating rods.

8. In a compressor construction having a reciprocating piston for compressing fluids and an internal engine for reciprocating said compressor piston, a starting mechanism for said internal engine comprising fluid inlets at the ends of the cylinder housing the compressor piston, a valve for alternately controlling the flow of fluid through said inlets, and electro-magnetic means for reciprocating said valve.

9. In a compressor including a plunger and an internal combustion engine for actuating said plunger, the improvement of a starter mechanism for said internal combustion engine comprising a valve member for controlling the flow of fluid under pressure from a source of supply, electro-magnetic means for effecting actuation of said valve to control the flow of fluid under pressure alternately to the ends of said plunger, and ignition means for said internal combustion engine operated at timed intervals by reciprocation of said plunger.

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