This invention relates to compressors, and more particularly to a combined compressor and engine each having a plurality of pistons which are actuated by a single crank.

One object of the invention is to construct an inherently balanced, compact and rugged engine unit that will require only a small space and is of such weight that it may be conveniently carried manually from place to place.

Other objects will be in part obvious and in part pointed out hereinafter.

In the drawings accompanying this specification and in which similar reference numerals refer to similar parts,

Figure 1 is a plan view of a compressor-engine unit constructed in accordance with the practice of the invention.

Figure 2 is a similar view, partly broken away, showing the piston and cylinder arrangement of the compressor and engine and the mode of connecting the pistons to the crank shaft of the unit.

Figure 3 is an elevation, partly in section, taken through Figure 1 on the line 3—3 and looking in the direction indicated by the arrows.

Figure 4 is an elevation, partly in section, of a portion of the oiling system of the unit.

Figure 5 is a transverse view taken through Figure 4 on the line 5—5.

Figure 6 is a similar view taken through Figure 5 on the line 6—6.

Figure 7 is an enlarged view, partly in section, of a compressor cylinder and associated parts taken through Figure 3 on the line 7—7 looking in the direction indicated by the arrows.

Figure 8 is a transverse view taken through Figure 3 on the line 8—8.

Figure 9 is an end view of an engine cylinder head taken through Figure 3 on the line 9—9.

Figure 10 is a transverse view taken through Figure 9 on the line 10—10.

Figure 11 is a side view, partly broken away, illustrating the manner in which the master connecting rod is connected to the other connecting rods of the unit.

Figure 12 is a transverse view taken through Figure 11 on the line 12—12, and

Figure 13 is a longitudinal side view of a detail.

Referring more particularly to the drawings, the compressor-engine unit, designated in its entirety by 20, is of the portable type. It comprises a frame 21 having a plurality of radiating extending wings 22 from which depend rods 23 that carry bearings 24 for shafts 25 having rollers 26 on their opposite ends.

The portion of the frame 21 lying above the arms 22 constitutes a crank case 27, shown as being of hexagonal shape, and in the flatted sides thereof are equi-angularly spaced apertures 28 to accommodate the inner ends of radially extending cylinders all lying in the same plane and three of which are designated 29 and serve as compressor cylinders. The remaining three cylinders, designated 30, serve as engine cylinders and are arranged in alternate relation with the compressor cylinders and each engine cylinder is positioned to lie diametrically opposite a compressor cylinder. Owing to this arrangement, each of the engine cylinders will be opposed by a compressor cylinder. Therefore, both the primary and secondary forces of the engine will be inherently balanced and the unit will operate smoothly and with a complete absence of vibration.

The cylinders 29 are provided with inlet and discharge valve mechanisms 31 and 32, respectively, for controlling communication between the cylinders 29 and inlet and discharge chambers 33 and 34 in heads 35 for the cylinders 29, and in the engine cylinder heads 36 are the usual inlet and exhaust spring-pressed poppet valves 37 and 38, respectively. The movement for opening the valves 37 and 38 is imparted thereto by rocker bars 39 and 40 and push rods 41 and 42 interposed between the rocker bars 39—40 and cams 43 and 44 on cam shafts 45 in the casing 21. The cam shafts 45 equal in number the number of engine cylinders and are rotated for four-cycle operation of the engine through gears 46 on the cam shafts 45 meshing with a gear 47 on the crank shaft 48 of the unit.

The cams 43—44 are positioned closely adjacent each other and the push rods 41—42 are inclined to bring their outer ends into the same horizontal plane for engagement with the thrust ends 49 of the rocker bars 39 and 40. The ends 49 of the rocker bars lie in closely spaced relation with each other as do also the push rods 41 and 42 and the portions of the latter lying exteriorly of the casing parts of the unit are encased by a single casing 50.

The casings 50 are preferably in the form of tubes and have their ends in telescopic engagement with the frame 21 and the heads 35 for holding the casings in the correct assembled positions. Suitable sealing members 51 are disposed about the exteriors of the casings 50 and bear against the frame 21 and the heads 35 to preclude the entrance of dirt into the unit.

The rocker bars 39 and 40 diverge from each other from the thrust ends 49 for contact at
and at the intermediate portions of the rocker bars are bearings 52 that are axially aligned with each other to receive a common shaft 53 that is supported at its ends by the head 35. The chamber containing the rocker bars is covered by a cap 54 which is secured to the head 35 by bolts 55 and the side walls of the cap 56 and the portion of the head enclosing the rocker bars converge toward the thrust end of said bars in order to minimize the weight of the unit. The tubes 59 are, for the same reason, also constructed of light weight material and by so arranging the push rods 41—42 that they may be encased in a common tube 60 instead of being separately encased, or arranged within the casing parts of the unit, the total weight of the unit may be further minimized.

The crank shaft 48 is common to the compressor and to the engine and has a single crank 56 for connection with the big end 57 of a master connecting rod 55 the opposite end of which is connected to an engine piston 59 by a wrist pin 60. The remaining two engine pistons 59 are operated by connecting rod 55 the master rod by links 61 and pivot pins 62, and similar pins 62 in the master rod serve as pivots for links 63 connected to two of the compressor pistons 64 by wrist pins 65.

Two pins 62 are arranged in the crank end of the rod 55 and two pins 62 in the cap 66 for the rod 56. These pins are provided with notches 67 in their peripheries for interlocking engagement with the bolts 68 that serve to secure the cap 66 to the master connecting rod 56.

The pin 69 serving to connect the link 33 of the remaining compressor piston 64 to the connecting rod cap 65 is hollow and has a radially extending hole 90 near one end to register selectively with either of holes 71 or 72 located at the opposite ends of the cap 66. The pin 69 is held against endwise movement by a key 70 in the hole 70 and one of the holes 71 or 72, depending upon the position of the pin 68 in the cap 66. The key 70 is preferably, as indicated, an integral portion of a spring member 74 which comprises a pair of arms 75 and 76 that are disposed angularly with respect to the key 70 and are joined together by a U-shaped spring portion 71. The arm 75 is of less length than the arm 74. Its free end bears against the exterior part of the key 70, and the portion of the arm 75 carrying the key 73 is bent out of the plane of the portion of said arm adjacent the U 77 and is flexed, in the locking position of the key 73, to retain the key in the holes.

The crank shaft carries counterweights 78 and is provided with anti-friction bearings 79 and 80 seated in the frame 21 on the opposite sides of the crank pin. On the portion of the crank shaft 48 lying below the bearing 80 is an oil pump 81 for pumping oil to the various bearing surfaces of the compressor and the engine. The pump 81 is arranged in an oil reservoir 82 defined by the lowermost portion 83 of the casing 21 which encircles the portion of the crank shaft 48 lying immediately below the crank case 21. The pump is a gear type and the casing 84 is shown as being formed integrally with a cover plate 85 for the reservoir 82 and encircles the shaft 43.

The pumping chamber 86 of the pump is located in the upper end of the casing 84 and contains a pair of intermeshing gears 87 and 88 the latter gear being keyed to the shaft 48 and the gear 87 being journaled on an idler shaft 89 seated in the casing 84. The oil pumped by the gears 87 and 88 is filtered by a screen 90 encircling the casing 84. It enters the pumping chamber 86 through bore 91 and is discharged through a passage 92 opening into a discharge chamber 93 in the lower portion of the casing 84 and encircling the shaft 48.

Within the shaft 43 is a passage 94 that communicates with the discharge chamber 93 through bore 95 and extends to the crank pin 96 for delivering oil to the cooperating surfaces of the crank pin and the master rod 90 and to deliver oil to the various bearing surfaces of the links connecting the compressor and engine pistons to the master rod 90.

Some of the oil discharged into the discharge chamber 93 by the pump is delivered to the upper portion of the frame 21 for splash lubrication of the bearing surfaces therein. To this end the discharge chamber 93 is provided with a discharge passage 95 that extends through the cover plate 85 and the frame 21 and opens into a conduit 97 leading to the frame 21 at a point above the gears 48 so that the oil discharged into the upper portion of the frame 21 will flow by gravity over the gears 48—49, the cams 43 and 44 and onto the anti-friction bearings 79 and 80.

During its course downward through the frame some of the oil will also splash upon the walls of the compressor and engine cylinders and upon the ends of the push rods 41 and 42 and will flow along the surfaces of the push rods into the heads 56 for lubricating the bearing surfaces of the rocker bars and the valve stems 57 and 58. Any excess oil delivered to the heads 56 will return by gravity through drain pipes 98 leading from low points in the heads 56 to the reservoir 32. Suitable openings 99 in the roof of the reservoir 32 will also permit oil to drain from the crank case 27 to the reservoir.

In order to prevent the occurrence of excessive pressure on the discharge side of the pump 81 the passage 96 is provided with a pressure relief valve mechanism 100. The valve mechanism 100 comprises a tubular frame 101 that extends into the reservoir 82 and is threaded into the cover plate 85. The body 101 has a passage 102 opening into the discharge passage 96 at one end and its other end is controlled by a ball valve 103 that is normally held in closed position by a spring 104 the force of which may be varied by a screw 105 threaded into the upper end of the body 101. Ports 106 in the wall of the body 101 permit the escape of oil from the interior of the body into the reservoir 32.

Suitable sealing means, designated in its entirety by 107, is disposed about the shaft 48 to preclude the leakage of oil from the lower end of the discharge chamber 93 to the exterior of the unit. In the form shown, the sealing means 107 comprises a flexible sealing ring 108 that bears with its peripheral surface against the wall of the chamber 93 and rests upon an annular plate 109 supported by a spring ring 110 in the wall of the chamber 93. The ring 108 is held in sealing engagement with the wall of the chamber 93 by a retainer 111 which extends into the sealing ring and is functionally held thereby against rotary movement.

The upper end of the retainer constitutes a sealing surface 112 that cooperates with a rotatable sealing member 113 to prevent leakage of oil from the chamber 93 to the portion of the shaft extending through the cover plate 85. The sealing member 113 lies within a holder 114, and a
rubber sleeve 115 in the holder embracing the shaft 48 serves as a yieldable abutment for the sealing member 113. A spring 116 interposed between the holder 114 and a washer 117 on the shaft 48, engages the holder and its content in the direction of the sealing surface 112.

In order to cause the quick dissipation of the heat of combustion and of compression and also to maintain the temperature of the oil in the reservoir 82 at a sufficiently low value to assure good lubrication, the unit is provided with a fan 118 on the lower end of the crank shaft 48 to pump air over the casing portion 83 and over and between the compressor and engine cylinders. The fan 118 lies outside of the casing 21 and beneath the reservoir 82 and its hub 119 is secured to the shaft 48 by a nut and at the outer margin of the web portion 120 of the fan is an annular flange 121 that supports the inner ends of the fan blades 122 which lie partly beneath the oil reservoir 82 so that a portion of the air pumped toward the cylinders by the fan will pass over the bottom and the peripheral surface of the casing 83 to cool the oil therein. The outer ends of the blades 122 are joined to a rim 123 which encircles the fan and is of light weight to add to the fan the fly-wheel effect required to assure smooth operation of the unit.

All of the air flowing to the compressor cylinders 29 for compression and to the engine cylinders 30 for supporting combustion passes through a common filter 124 which is seated on a manifold 125 overlying the unit. At the periphery of the manifold are outlet openings 126 that connect with the inlet members 33 of the heads 35 through conduits 127. The air conveyed thereby enters the compressor cylinders 29 through the inlet valves 31 and, upon compression, passes through the discharge valves 32 into the discharge chamber 34. The air is then discharged through conduits 128 depending from into a manifold 129 that encircles the fan 118 to serve as a guard therefor. A suitable discharge conduit 19 communicating with one of the discharge chambers 34 conveys the compressed fluid to a point of utilization.

The manifold 125 is shown superimposed upon the fuel carburetor 130, for the engine, which has an air intake conduit 131 extending through the lower wall of the manifold to communicate with the interior thereof. The fuel constituent of the fuel charges for the engine cylinders is conveyed to the carburetor 130 by a pipe 132 leading from a suitable filtering device 133 and the combustible mixture issuing from the carburetor enters a chamber 134 beneath the carburetor, whence it passes through conduits 135 to inlet passages 136 in the heads 36 for admission into the engine cylinders.

The exhaust of the products of combustion from the engine cylinders is controlled by the discharge valves 38, as is well understood, and passes into exhaust passages 137 in the heads 36 and through exhaust pipes 139 to the atmosphere. The exhaust pipes 138 occupy horizontal positional relations and their outlet ends 139 lie outside of the path of the current of air flowing upwardly from the fan 118 to avoid the introduction of the hot exhaust gases into the air stream.

The distribution of electrical current for igniting the fuel charges in the engine cylinders is controlled by a suitable distributor 140 on the frame 21 driven by the crank shaft through gears 141 and 142 and having the usual cables 143 for carrying the current to the spark plugs 144 in the heads 36.

Means are provided for manually starting the engine. To this end a shaft 145 is journaled in the frame 21 and carries a pinion 146 to mesh with a gear 147 on the crank shaft 48. On the opposite end of the shaft 64 is a clutch member 148 for cooperation with a complementary member 149 carried by a shaft 150 rotateable in a bearing 151. The shaft 150 may be movable endwise in a well known manner within the bearing 151 for effecting engagement and disengagement of the clutch members, and on the outer end of the shaft 150 is a sheave 152 having a rope 153 wound thereon for rotating the shafts to start the engine.

The unit being of light weight may be readily lifted manually for placing it in a desired position and is accordingly provided with a tubular member 154 which lies in a horizontal position at the upper end of the frame 21 to receive a removable carrying rod 155. The rod 155 is preferably of such length that its terminal portions may be conveniently gripped at opposite sides of the unit, and the tubular member 154 is so positioned that the rod 155 may be conveniently inserted therein without hindrance by the adjacent parts of the unit. The tubular member 154 may be secured to the frame 21 in any suitable manner, as for instance, by brackets 156 connected thereto and secured to the frame 21 by bolts 157.

From the foregoing description it will be readily apparent to those familiar with machines of the character described that by constructing the engine of the unit of three cylinders and opposing each engine cylinder with a compressor cylinder, both the primary and secondary forces of the engine will be inherently balanced. The unit may, therefore, be of light-weight construction and the fly-wheel weight required for its smooth operation may also be reduced to a minimum. A further highly desirable feature of the present invention is that, owing to the arrangement of the fan 118 beneath the unit, cool air will be caused to circulate over the oil reservoir and the compressor and engine cylinders and the temperature of these parts and of the oil will at all times be of a value well suited to assure the efficient operation of the unit and the adequate lubrication of its bearing surfaces.

Owing, moreover, to the arrangement of the air filter 124, the manifold 125, chamber 134 and the carburetor 130 all of the air delivered to the engine and compressor cylinders may be cleansed by a single filter which need be of no greater size than that required for any of the individual cylinders.

I claim:

1. In a combined compressor and engine, a plurality of radially extending compressor cylinders, a plurality of radially extending engine cylinders arranged in alternate relation with the compressor cylinders and each engine cylinder lying opposite a compressor cylinder, reciprocating pistons in the compressor and engine cylinders, a common crank shaft for all the pistons having only one crank, connecting rods for connecting the pistons to the crank, a fan on the crank shaft for blowing air against the cylinders, and a reservoir for oil between the fan and the cylinders and in coaxial relation with the fan extending into the air stream flowing from the fan to the cylinders.

2. In a combined compressor and engine, a
plurality of radially extending cylinders all lying in the same horizontal plane and each cylinder lying opposite another cylinder, means for rendering alternate cylinders operative as compressor cylinders, a plurality of radially extending engine cylinders, reciprocatory pistons in the cylinders, a vertical common crank shaft for the pistons having only one crank, connecting rods for connecting the pistons to the crank, a fan on the lower end of the crank shaft for blowing air against the cylinders, and a reservoir for oil extending with its peripheral portion into the air stream flowing from the fan to the cylinders.

3. In a combined compressor and engine, a plurality of horizontally disposed radially extending cylinders all lying in the same horizontal plane, means for rendering alternate cylinders operative as compressor cylinders, means for rendering the remaining cylinders operative as engine cylinders, reciprocatory pistons in the cylinders, a vertical common crank shaft for the pistons having only one crank, connecting rods for connecting the pistons to the crank, a casing beneath the cylinders to encircle the crank shaft and forming a reservoir for oil for the compressor and the engine, and a flywheel for the shaft having fan blades positioned to blow air against the bottom and the peripheral surface of the casing and over all of the cylinders.

4. In a combined compressor and engine, a plurality of radially extending compressor cylinders, a plurality of radially extending engine cylinders arranged in alternate relation with the compressor cylinders, inlet and exhaust valves for the engine cylinders, pistons in the compressor and engine cylinders, a common crank shaft for the pistons having only one crank, means for transmitting motion from the crank shaft to the valves, connecting rods for connecting the pistons to the crank, there being a passage in the crank shaft for conveying oil to the connecting rods, a pump driven by the crank shaft for pumping oil to the passage and having a discharge chamber encircling the crank shaft and in constant communication with the passage, and conduit means for conveying oil from the discharge chamber having its outlet end so positioned with respect to the motion transmitting means that the oil discharged therefrom will gravitate onto the said motion transmitting means.

5. In a combined compressor and engine, a plurality of radially extending compressor cylinders, a plurality of radially extending engine cylinders arranged in alternate relation with the compressor cylinders, inlet and exhaust valves for the engine cylinders, rocker bars to engage the valves with one end and converging toward each other to bring their other ends into closely spaced engagement with each other, pistons in the compressor and engine cylinders, a common crank shaft for the pistons, a common cam shaft for the inlet and exhaust valve of each cylinder, means for transmitting movement from the crank shaft to each cam shaft, pairs of push rods extending along the exteriors of the cylinders for transmitting movement from the cam shafts to the rocker bars, and tubular casings for incasing each pair of push rods.

6. In a combined compressor and engine, a plurality of radially extending compressor cylinders, a plurality of radially extending engine cylinders arranged in alternate relation with the compressor cylinders, reciprocatory pistons in the cylinders, a common crank shaft for the pistons having only one crank, a master connecting rod on the crank connected to one piston, a cap for the connecting rod, connecting rods for the remaining pistons, pins for connecting the last mentioned connecting rods to the master connecting rod and the cap, bolts for securing the cap to the master connecting rod and to interlockingly engaging the said pins against endwise movement, and a spring key within the remaining pin having a leg in interlocking engagement with the said remaining pin and the cap.

ELLSWORTH C. COWLES.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

<table>
<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>911,540</td>
<td>Guilford</td>
<td>Feb. 2, 1909</td>
</tr>
<tr>
<td>963,788</td>
<td>Merrill</td>
<td>July 12, 1910</td>
</tr>
<tr>
<td>1,450,032</td>
<td>Gardner</td>
<td>Mar. 27, 1923</td>
</tr>
<tr>
<td>1,506,674</td>
<td>Szewner</td>
<td>Aug. 26, 1924</td>
</tr>
<tr>
<td>1,694,218</td>
<td>Hazard</td>
<td>Dec. 4, 1928</td>
</tr>
<tr>
<td>1,804,873</td>
<td>Hoffman</td>
<td>May 12, 1931</td>
</tr>
<tr>
<td>1,819,691</td>
<td>Rix</td>
<td>Aug. 18, 1931</td>
</tr>
<tr>
<td>1,840,045</td>
<td>McCormack</td>
<td>Jan. 5, 1932</td>
</tr>
<tr>
<td>1,882,332</td>
<td>Des Roches</td>
<td>Dec. 27, 1932</td>
</tr>
<tr>
<td>1,935,508</td>
<td>Fowler</td>
<td>Jan. 31, 1933</td>
</tr>
<tr>
<td>1,934,880</td>
<td>Pyx et al.</td>
<td>Nov. 14, 1933</td>
</tr>
<tr>
<td>2,103,861</td>
<td>Melcher</td>
<td>Dec. 26, 1938</td>
</tr>
<tr>
<td>2,133,769</td>
<td>Jones</td>
<td>Oct. 18, 1938</td>
</tr>
<tr>
<td>2,141,957</td>
<td>Whiles</td>
<td>Dec. 20, 1938</td>
</tr>
<tr>
<td>2,395,315</td>
<td>Letz</td>
<td>June 2, 1942</td>
</tr>
</tbody>
</table>