The present invention relates to tandem engine compressors and more particularly to directly connected engine and compressor piston arrangements.

The primary object of this invention is to provide a tandem engine compressor in which dual opposed pistons of the engine are directly connected to the compressor pistons.

Another object of the invention is to provide a device of the character described in which the reciprocating piston power is transmitted directly to the compressor.

A further object of the invention is to provide a device of the character described in which a crank shaft maintains the timing of the reciprocating pistons.

Still further objects of the invention is to provide a device of the character described which is considerably more compact than separated units of equal power.

Other objects and advantages will become apparent in the following specification when read in the light of the attached drawings, in which:

Figure 1 is a top plan view of the engine compressor, partly broken away, and illustrating in section the working elements of the tandem engine compressor.

Figure 2 is a vertical cross-section taken on the line 2-2 of Figure 1, looking in the direction of the arrows.

Figure 3 is a diagrammatic view of the crank shaft through angles.

Figure 4 is a transverse cross-section of the guide assembly taken on the line 4-4 of Figure 2, looking in the direction of the arrows.

Figure 5 is a top plan view of a modified form of tandem engine compressor, partly broken away and illustrating in section the working elements of the engine compressor.

Figure 6 is a transverse cross-section taken on the line 6-6 of Figure 5, looking in the direction of the arrows.

Figure 7 is a lateral cross-section taken on the line 7-7 of Figure 5, looking in the direction of the arrows.

Now, referring to the drawings in detail, in which like numerals designate like parts throughout the several figures, reference numeral 10 indicates generally the tandem engine compressor comprising the preferred embodiment of the present invention.

The tandem engine compressor 10 includes a casing 11 in which is mounted a pair of cylinder sleeves 12 disposed on opposite sides of the casing 11. The sleeves 12 are mounted in cylinder blocks 13 integrally cast with the casing 11, and forming a water jacket 14 surrounding and cooling the sleeves 12. Lubricant may be supplied to the sleeves 12 through channel 16. The cylinder sleeves 12 are closed by members 17 which are secured to the cylinder blocks 13 and having a packing chamber 18 projecting into the sleeve 12. The packing chamber 18 is internally screw threaded to receive an externally threaded packing nut 19, which holds the packing 20 within the chamber 18.

Each cylinder sleeve 12 has positioned therein a pair of reciprocating pistons 21 which are disposed in opposed relation. A pair of rigid piston rods 22 have one of their ends secured to each of the pistons 21, respectively, and the other ends thereof extend through the packing 20 and the packing nuts 19. The pistons 21 are provided with suitable piston rings 23 and oil control rings 24. Midway between the opposed pistons 21, a fuel injector 25 is mounted through the side of the casing 11, cylinder block 13, and extends through the wall of the sleeve 12 so that fuel may be injected into the sleeve 12 between the opposed pistons 21.

The sleeves 12 are provided with scavenging air ports 26 which communicate with the air box 15. Exhaust ports 27 are also positioned in the sleeve 12 and communicate with an exhaust duct 28. It should be understood that as many injectors 25 will be provided as are found to be necessary for the operation of the engine 10.

A compressor, generally indicated by reference numeral 29, is positioned midway between the spaced apart cylinders 12 with a compressor 29 at each end of the casing 11. The compressor 29 consists of a cylinder 30 which is secured to the casing 11 and extends inwardly thereof. The cylinder 30 may be provided with a water jacket 31 for cooling the cylinder 30. A piston 32 is mounted for reciprocation in the cylinder 30 and is rigidly secured to a piston rod 33 by any suitable means. Automatically operating intake valve 34 admits gas through the intake port 35 and automatic exhaust valve 36 permits the gas to be discharged through discharge port 37. The piston 32 is provided with piston rings 38 to seal the piston 32 in the cylinder 30.

A rigid yoke 39 is secured to the outer ends of the spaced apart piston rods 22, by means of connectors 40. The yoke 39 has an inwardly offset portion 41 having a crosshead pin 42 extending across the inner end of the cylinder 30 to the opposite offset portion 43. The piston rod 33 is rigidly secured to the center of the crosshead pin 42 of the yoke 39 so that the piston 32 will reciprocate with the piston 21. A second yoke 39 is provided for the spaced opposed pistons at the opposite end of the casing 11 and is secured to another compressor 29.

A crank shaft 44 is mounted for rotation in bearings 45. The crank shaft 44 is provided with a flywheel flange 46 at each end thereof and a flywheel 47 is secured to each of the flywheel flanges 46. A connecting rod 48 is secured to a throw 49 of the crank shaft 44 by bearing 50 and the connecting rod 48 is secured to the crosshead pin 42 by means of bearing 51. A similar connecting rod 52 is connected to the throw 53 of the crank shaft 44 by means of bearing 54. The connecting rod 52 is connected to the second compressor system in the same manner as the connecting rod 48 connects to the first compressor system.

The throws 49 and 53 of the crank shaft 44 may be positioned at an angle of other than 180° to each other, as shown in Figure 3, so that the exhaust ports 27 may open sooner and also close sooner than the inlet ports 26. This arrangement promotes good scavenging.

The crosshead pin 42 carries a spacer 55 which assists in maintaining the piston rod 33 in position thereon. A pair of spaced apart arcuate guides 56 are mounted in the casing 11 with their axes in alignment with the axis of the cylinder 30. A pair of opposed arcuate slides 57 engage the inner faces of the guides 56 and are secured at their opposite ends to the offset portions 41 and 43, respectively. A pair of support plates 58 are provided from the arcuate slides 57 to the inner end of the crosshead pin 42 supporting bosses 59 formed on the offset portions 41 and 43.

In the use and operation of the invention disclosed in Figures 1 through 4, the engines are furnished with compressed air through the air box 15 and fuel is introduced through the fuel injectors 25 when the pistons 21 are at
their innermost position. The explosion of the fuel will drive the pistons 21 outwardly in the sleeve 12, moving the piston rods 22 and yoke 39 outwardly, which will, in turn, impinge the pistons 32 outwardly in the cylinders 39, delivering a charge of compressed gas through the discharge valve 36.

The movement of the pistons 21 in the sleeves 12 toward the member 17 compresses air between the piston 21 and the member 17, which causes the pistons 21 to bounce back toward each other and thereby assists the flywheels 47 to maintain the smooth power flow of the reciprocating pistons 21 to get them past their outer dead center.

The crank shaft 44 will maintain the opposed pistons 21 in timed relation so that there will be no tendency for one of the pistons 21 to get out of phase. In addition, the flywheels 47 mounted on opposite ends of the crank shaft 44 will store kinetic energy and maintain the even movement of the pistons 21 in the sleeves 12. Obviously, since little or no power is transmitted through the crank shaft 44 on the connecting rods 48 and 52, these elements will be under considerably less strain than is ordinary in conventional reciprocating engines, and consequently they will be much less apt to become worn or damaged due to the operation of the device.

While there has been no disclosure of specific devices for furnishing the scavenging air, cooling water, lubricating oil, etc., it should be understood that this engine will be provided with conventional forms of devices for performing the conventional functions.

In Figures 5 through 7 of the drawings, a modified form of the invention is disclosed with a casing 11' having a pair of spaced apart engine cylinders sleeves 12', the construction of which along with its pistons (not shown) is identical to the engine cylinders sleeves 12 disclosed in Figure 1, and are mounted in cylinder blocks 13' in the same manner as the sleeves 12 are mounted in the cylinder blocks 13.

A crank shaft 44' is positioned between the engine cylinders sleeves 12' and has its axis of rotation extending perpendicular to a plane passing through the axis of each of the cylinder sleeves 12'. The crank shaft 44' is supported by split bearings 45' which are carried by bearing support 45e extending from the casing 11'. The crank shaft 44' is provided with a pair of throws 49' and 53' which are slightly out of line so that the angle of the line passing through their axes and through the axis of the center of the crank shaft 44' will be other than 180°, as in the preferred form.

A pair of cylindrical guides 56' are positioned in axial alignment with their axis passing through the axis of the crank shaft 44' perpendicular thereto. A cylindrical slide 57' is mounted for reciprocation in each cylindrical guide 56'. A transversely extending crosshead pin 42' is mounted in each slide 57'. A connecting rod 52' extends from the throw 53' of the crank shaft 44' in the crosshead pin 42' in one of the slides 57', and a second connecting rod 48' extends from the throw 49' of the crank shaft 44' to the crosshead pin 42' in the other slide 57'.

A compressor cylinder 30' is mounted to each end of the casing 11' and is axially aligned with the guides 56'. The cylinders 30' project outwardly from the casing 11' and each of them is provided with a piston 32', an automatic inlet valve 34', and an automatic discharge valve 36'.

The pistons (not shown) in the sleeves 12' are each provided with a piston pin 22' projecting outwardly therefrom.

The outer ends of the piston rods 22' are slotted at 22a (see Figure 6) and have a connector web 40' extending laterally therefrom in a plane extending through the axis of the cylinders 30'. A rigid integral flat yoke 39' of generally X shape has laterally extending arms 39a, the outer ends of which are secured to the inner ends of the connector web 40'. The yoke 39' is further provided with an outwardly extending arm 39b carrying a flange 39c on the outer end thereof. The piston 32' is rigidly secured to the flange 39c. An inwardly extending arm 39d is provided with a flange 39e on the inner end thereof which is rigidly secured to the slide 57'.

The operation of the modified form of the invention disclosed in Figures 5 through 7 is the same as the operation of the preferred form of the invention. The crank shaft 44' extending at right angles to the plane of the axes of the sleeve 12' permits the ends of the crank shaft 44' to extend through the casing 11' so that engine accessories, power take off, etc., as well as additional tandem engine compressor units may be attached in line.

Having thus described the preferred embodiments of this invention, it should be understood that various modifications may be resorted to without departing from the scope of the appended claim.

What is claimed is:

A tandem engine compressor comprising a casing, a pair of spaced apart parallel engine cylinders mounted in said casing, a pair of opposed engine pistons mounted in opposite ends of each of said engine cylinders, a compressor cylinder positioned centrally of said spaced apart engine cylinders at each end of said casing with the axis of said compressor cylinders lying parallel to the axes of said engine cylinders, a compressor piston mounted for reciprocation in each of said compressor cylinders, means at each end of said casing rigidly connecting the said compressor piston at each end of said casing with the pair of said engine pistons in the adjacent ends of said spaced apart engine cylinders, and means linking together the rigid connecting means at opposite ends of said casing for maintaining said connecting means in phase, with said last named means including a crank shaft having flywheels mounted on each end thereof, and means connecting said crank shaft to said rigid means whereby the movement of said pistons in said cylinders may be timed.

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