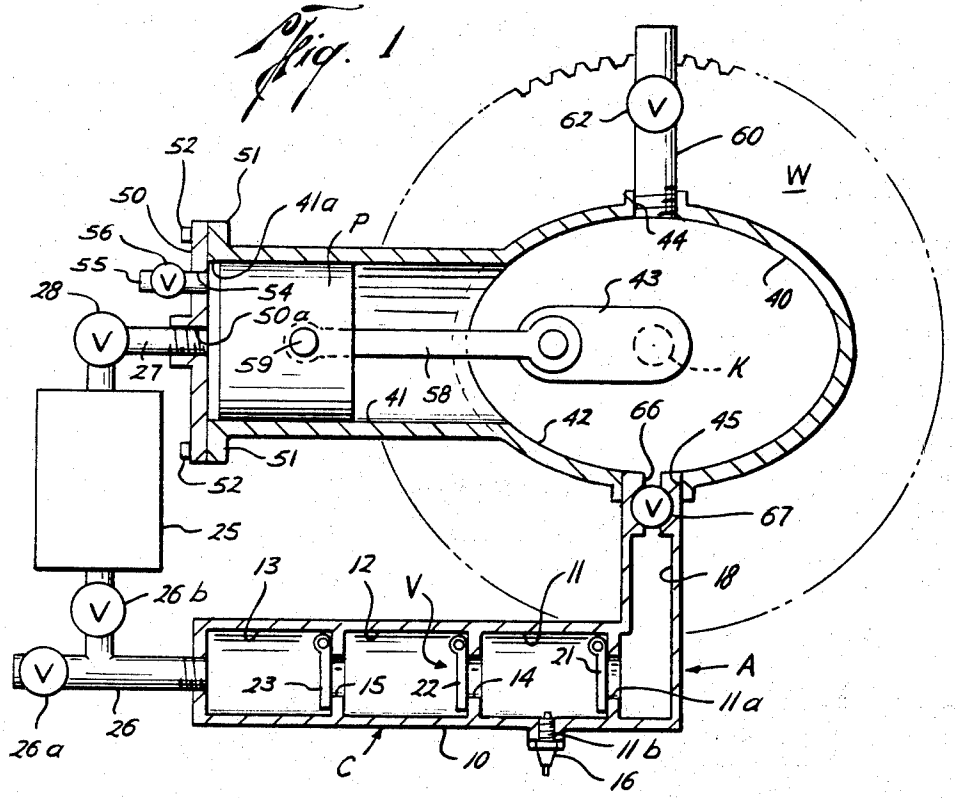
Oct. 29, 1968 W. P. McCOMB 3,407,594

GAS COMPRESSOR APPARATUS

Filed Dec. 5, 1966

Fig. 1



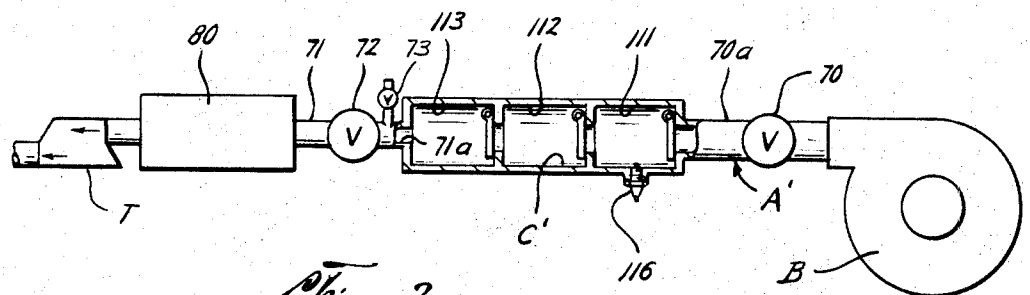


Fig. 2

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3,407,594

GAS COMPRESSOR APPARATUS

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Continuation-in-part of application Ser. No. 457,617, May 21, 1965. This application Dec. 5, 1966, Ser. No. 607,111

1 Claim. (Cl. 60—39.6)

ABSTRACT OF THE DISCLOSURE

An inert gas compressor comprising a plurality of interconnected stages or chambers having one-way valves therebetween for controlling the flow of fluid therethrough in one direction and a terminal valve in the final chamber for closing off flow in such direction so that when a combustible charge is ignited successively in each of such chambers with the terminal valve closed, the pressure of such charge will be progressively increased in each succeeding chamber. Thereafter, the terminal valve may be opened to release the pressure from the chambers before a fresh combustible charge is introduced therein.

This application is a continuation-in-part of the copending application filed May 21, 1965 bearing Serial No. 457,617.

An object of the present invention is to provide a new and improved gas compression device having a succession of interconnected chambers wherein a combustible mixture is ignited successively as the flame spreads from one chamber to the next to increase the pressure of the mixture in each of the succeeding chambers.

Another object of the present invention is to provide a new and improved inert gas compressor having a first chamber and a second chamber connected together by one-way valve means whereby a combustible mixture ignited in the first chamber will expand to increase the pressure of the combustible mixture in the second chamber and thereafter the flame from the first chamber will ignite the pressurized combustible mixture in the second chamber.

Another object of the present invention is to provide a new and improved inert gas compressor having a plurality of pressure chambers connected together in succession wherein each chamber is connected to its adjacent chamber by means of a one-way valve whereby a combustible mixture ignited in one of such pressure chambers will expand the combustible mixture in each of the successive chambers and will ignite such expanded mixture in each of such chambers as the ignition flame travels from one chamber to the next chamber.

Still a further object of the present invention is to provide a new and improved gas compressor apparatus having a plurality of pressure chambers connected in succession with each of the chambers having a one-way valve which is adapted to open when a combustible mixture in a preceding chamber is ignited and to close when a combustible mixture in its chamber is ignited.

And yet another object of the present invention is to provide a new and improved gas compressor apparatus including a plurality of combustion chambers each having a discharge port and an inlet port with a one-way valve in said inlet port for admitting a combustible mixture to such chamber and for closing off communication through such inlet port when such mixture is ignited.

A further object of the present invention is to provide a new and improved gas compressor having a plurality of combustion chambers, each having a discharge port and an inlet port with a one-way valve in said inlet port wherein such combustion chambers are arranged in succession, with the discharge port of each combustion chamber connected to the inlet port of the adjacent succeeding combustion chamber so that a combustible mixture ignited in one of such chambers will expand to close the one-way valve in the inlet port thereof and to expand the combustible mixture in the succeeding chambers.

The preferred embodiment of this invention will be described hereinafter together with other features thereof, and additional objects will become evident from such description.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings forming a part thereof wherein an example of the invention is shown and wherein:

FIG. 1 is a view partly schematic and partly in elevation showing the gas compressor apparatus of the present invention connected to piston means for rotating a flywheel and crankshaft; and

FIG. 2 is a schematic view showing the apparatus of the invention connected to a turbine for rotating the rotor thereof.

The gas compressor apparatus of this invention, designated generally at A in FIG. 1 of the drawings, includes a plurality of successive chambers C in which a combustible charge is ignited and expanded. Such chambers C are connected together in sucession with a one-way valve member V positioned between adjacent chambers C. With the apparatus A of this invention, when a charge of combustible gas is ignited in one of such chambers C, the gas expands and elevates the pressure of the unburned charge of combustible gas in the succeeding chambers C. As flame propagation spreads into each successive chamber C, the flame ignites a portion of the combustible mixture therein causing it to expand. The expanding gas shuts the valve V between the chamber in which combustion is occurring and the preceding chamber and opens the valve V leading to each of the succeeding chambers and increases the pressure of the gas in each of such succeeding chambers prior to igniting such precompressed gas. Thus, it will be appreciated that with the apparatus of this invention, the pressure of a combustible gas mixture or charge may be increased manyfold with a minimum of moving parts. Also, with the gas compressor apparatus of this invention, a combustible mixture may be ignited and expanded in as many successive stages or successive chambers as desired to expand such combustible mixture to a desired pressure.

Considering now the apparatus of the present invention in more detail, the plurality of combustion chambers C which are best seen in FIG. 1 of the drawings are preferably formed in a block or body **10**, or may be formed in separate bodies or housings and joined together, as desired. As shown in FIG. 1, the plurality of combustion chambers C preferably comprises an initial combustion chamber **11**, an intermediate combustion chamber **12**, and a terminal combustion chamber **13**. Such chambers are preferably arranged in sequential order with the chamber **11** connected to the chamber **12** by means of a passage **14** and the chamber **12** connected to the chamber **13** by means of a passage **15**, as will be explained more fully herein.

Normally, the initial chamber **11** has an inlet passage **11***a* connecting the chamber **11** with a fuel supply chamber **18** as will be explained hereinafter.

A one-way valve member **21** is positioned adjacent such inlet port **11***a* for controlling fluid flow therethrough. Such chamber **11** also has a port or opening **11***b* provided therein which is adapted to receive a spark plug or other ignition device **16** for igniting an air-fuel mixture or combustible charge in the chamber **11**. The ignition device **16**

may be actuated at desired intervals by means of suitable timing devices well known in the art.

The inlet port **11***a* is preferably connected to a fuel supply chamber **18** which supplies fuel such as natural gas, gasoline, or some other suitable combustible fuel to the combustion chambers **11**, **12**, and **13**, as will be explained. However, such fuel supply chamber **18** may be positioned at a remote location relative to the combustion chambers C with a suitable conduit (not shown) connected to the chamber **11** by welding or other connecting means.

The one-way valve **21** is preferably adapted to be opened inwardly relative to the chamber **11** to allow a combustible mixture to be introduced therein and to be closed by the expansion of such combustible mixture when it is ignited in the chamber **11**. Normally, the combustible mixture will be forced into the interconnected chambers **11**, **12**, and **13** by means of a piston P, as will be explained herein, or such combustible mixture may be blown by some suitable type of blower, as desired.

The intermediate chamber **12** is connected to the terminal chamber **13** by the passage **15** and similarly, the passage **14** connects the chambers **11** and **12**. Also, as shown, the chambers **12** and **13** have one-way valves **21** and **22** which are provided for controlling flow through the passages **14** and **15**, respectively. Such valves **21** and **22** are adapted to open inwardly relative to the chambers **12** and **13** to receive a combustible mixture therein in substantially the same manner as the valve **21** opens to admit fluid to the chamber **11**. Such valves **21** and **22**, respectively, are also adapted to be closed when the combustible mixture in each of the respective chambers **12** and **13** is ignited and expanded.

A combustible fuel may be forced or fed from the fuel supply chamber **18** through the passage **11***a* into the chamber **11** and then through the passage **14** into the chamber **12** and similarly, through the passage **15** into the chamber **13**, as will be described herein. Thereafter, such combustible mixture is ignited in the successive chambers **11**, **12**, and **13** whereby it is greatly expanded and its pressure is greatly increased, as will be explained.

A pressure chamber **25** is preferably provided for receiving the pressurized combustible mixture from the chamber **13** to drive the piston P. Such pressure storage tank or chamber **25** is connected to the terminal chamber **13** by a conduit **26** or other suitable connecting means. The conduit **26** preferably forms a "Y" with valve means **26***a* and **26***b* in each of the branches of the "Y," as shown schematically in FIG. 1 of the drawings.

The valve member **26***a* is preferably a time controlled valve that is provided for exhausting gas from the combustion chambers **11**, **12**, and **13** to the atmosphere and to thus facilitate the introduction of a fresh charge of gas to such chambers. The valve member **26***b* is preferably a check valve which confines pressure in the chamber C. Such valve opens to flow in only one direction to enable gas to pass from the combustion chambers **11**, **12**, and **13** into the pressure storage chamber **25** and to prevent any back flow from such chamber **25**. It will be appreciated that the pressure actuated valve member **26***b* may have adjustable tension so that it normally remains closed and will open to allow flow only when a predetermined pressure is imposed thereon and which will remain closed in the absence of such pressure. Also, such valve **26***b* may be manually operated or may be time actuated, as desired; however, it confines pressure in the chambers C except when it opens to allow gas under pressure to flow to the gas pressure chamber **25**. The gas pressure chamber **25** is connected to a piston cylinder **41** by means of a conduit **27** which also preferably has a timed inlet valve **28** therein for regulating the flow of gas pressure to the piston cylinder **41**.

As shown, the piston P, which is adapted to be driven by the expanded fuel mixture from the plurality of the combustion chambers C, is provided for rotating a crankshaft K on which is mounted a flywheel W in a manner well known in the art. Such crankshaft K is normally mounted in a crankcase or crankshaft housing **40** on bearings (not shown) in which the crankshaft K is journaled in the usual manner.

The crankcase **40** includes a cylindrical portion **41** which is adapted to receive the piston P which may be reciprocated therein to rotate the crankshaft K, as will be explained. Similarly, the crankcase **40** includes a hollow portion or chamber **42** in which the crankshaft throw **43** rotates.

The cylindrical chamber or cylinder **41** has its outermost end **41***a* closed by means of a cylinder head **50**. An annular ring or flange **51** is normally formed near the end **41***a* of such cylinder **41** for receiving connecting means such as bolts **52** or other suitable connecting means, for securing the head **50** the flange or ring **51**.

As shown, the cylinder head **50** has a port or opening **50***a* formed therein for receiving one end of the pressure conduit **27** for conducting fluid pressure to the piston cylinder **41** from the chamber **25**. Such pressure conduit **27** may be secured in the opening **50***a* by welding or other suitable connecting means, as desired.

An exhaust port or opening **54** is provided in the cylinder head **50** for exhausting the expanded combustible fuel mixture from the piston cylinder **41**, as will be described. An exhaust conduit **55** is shown connected in the exhaust port **54** for conducting the exhaust gases from the chamber **41**. Such exhaust conduit **55** is connected by welding or other suitable connecting means in the port **54**. As shown, the exhaust conduit **55** is provided with a timed exhaust valve **56** which is opened when desired.

The piston P which is slidably mounted in the cylinder **41** is normally connected to the crankshaft throw **43** by means of a standard connecting rod **58** which is secured in the piston P by means of a pin **59** in the manner well known in the art.

As shown, the crankcase chamber **42** has an inlet port **44** and a discharge port **45** formed therein for conducting a combustible mixture therethrough as will be explained. The inlet port **44** is adapted to receive a fluid conduit **60** which is secured in such inlet port by any suitable means such as welding or the like. Such conduit **60** normally has a check valve **62** therein which is adapted to allow the combustible mixture or fuel to pass into the chamber **42** through the port **44** and which is adapted to close to prevent fluid flow out of the chamber **42**. The discharge port **45** is adapted to receive a fuel conduit **66** which is provided for conducting the combustible mixture or air-fuel mixture from the crankcase chamber **42** to the fuel supply chamber **18**. As shown in the drawings, a valve **67** is provided at the discharge port **45** which is adapted to be opened to permit fluid to flow into the fuel chamber **18** and to close to prevent fluid from flowing to the chamber **42** from the chamber **18**.

In operating the apparatus A, the crankshaft K may be rotated axially by a manual crank or other cranking means well known in the art to reciprocate the piston P in the cylinder **41**. When the piston P is reciprocated from the position adjacent the end **41***a* of the cylinder **47** to the right as viewed in FIG. 1 of the drawings, the check valve **62** will be closed and the combustible mixture or fluid in the chamber **42** will be forced through the valve **67** into the fuel supply chamber **18**. With the valve **26***a* open, the pressure of such combustible mixture will open the one-way valves **21**, **22**, and **23**, respectively, to allow such combustible mixture to pass into the chambers **11**, **12**, and **13**. Thereafter, the timed valve **26***a* will be closed. When the piston P reaches the end of its inward stroke, it is then reciprocated outwardly or to the left as viewed in FIG. 1 of the drawings. As such piston P is reciprocated to the left or toward the end **41***a* of the cylinder **41**, the check valve **62** is opened and a supply of combustible fuel is drawn through the conduit **60** into the chamber **42**. Such fuel remains therein until it is forced into the fuel supply chamber **18** from which it passes into the chambers **11**, **12**,

and 13 as described above when the piston P is reciprocated to the right from the end of its outward stroke or from its position as shown in FIG. 1 of the drawings.

After the combustible material or fuel-air mixture is forced into the chambers 11, 12, and 13, the combustible mixture in the chamber 11 is ignited by means of a spark from a spark plug 16 or other suitable ignition means. When so ignited, the fuel-air mixture in the chamber 11 expands to close the one-way valve 21 to close off communication through the passage 11*a* and to open the one-way valves 22 and 23, respectively.

Such expansion of the ignited fuel in the chamber 11 also compresses the combustible mixtures in the chambers 12 and 13 thereby elevating their pressure. Thereafter, when the flame from the ignited combustible mixture in the chamber 11 reaches the precompressed combustible mixture in the chamber 12, the flame will ignite such precompressed combustible mixture. The ignition of the fuel in the chamber 12 closes the valve 22, expands the combustible mixture therein, and further compresses the precompressed air-fuel mixture in the chamber 13. Similarly, when the combustible mixture in the chamber 13 is ignited by the flame from the combustible mixture in the chamber 12, the one-way valve 23 is closed and the precompressed combustible mixture in the chamber 13 is further expanded as it burns.

The valves 26*a* and 26*b* both normally remain closed while combustion is occurring in the chambers 11, 12, and 13 so that the pressure of the combustible charge will progressively expand to the maximum in each succeeding chamber as flame propagation moves through such chambers to produce the greatest elevation in the pressure in the final chamber 13. After combustion in the final chamber 13 is substantially complete, the valve 26*b* is opened to release the pent up pressure to the chamber 25. After the valve 26*b* has been opened to release pressure from the chamber 13 to the chamber 25 and is again closed, the exhaust valve 26*a* is then opened to allow a fresh charge of combustible gas to be forced into the chambers 11, 12, and 13, respectively, and to thereby exhaust any residue gas remaining from prior combustion in such chambers through such valve 26*a*.

Such compressed or pressurized gas or air-fuel mixture will be conducted by way of the conduit 26 from the terminal combustion chamber 13 through the valve 26*b* to the pressure chamber 25 where such pressurized gas is stored awaiting the opening of the timed inlet valve 28. When the piston P is returned to the position shown in FIG. 1 of the drawings, the valve 28 is then opened and the pressurized gas is introduced into the piston cylinder 41 for moving the piston P to the right as seen in FIG. 1. The piston P which is connected by means of the piston rod 58 to the throw 43 will thus rotate the crankshaft K and flywheel W. While the piston P is moving toward the outer end 41*a* of the cylinder 41, the exhaust valve 54 is opened to enable the piston P to exhaust or expel the residue of the pressurized gas to the atmosphere.

It should be noted that although one group or series of successively arranged chambers 11, 12, and 13 is shown for purposes of illustration, additional series of combustion chambers may be provided for driving such piston. Furthermore, substantially any number of intermediate chambers may be provided between the initial chamber 11 and the terminal chamber 13 to further compress the combustible mixture in additional successive stages and thereby increase the pressure of the gas supplied to the chamber 25 for driving the piston P or operating other pressure actuated tools which may be connected to the chamber 25. Also, additional pistons could be added to the crankshaft K, each having its own series or succession of combustion chambers or additional pistons could be driven from a single series of chambers C.

In FIG. 2 of the drawings is shown another embodiment of the apparatus of the present invention which is there designated generally by the letter A'. The apparatus A' preferably comprises a series of combustion chambers C' which includes chambers 111, 112, and 113, respectively, which are substantially identical to the series of combustion chambers C illustrated in FIG. 1 of the drawings. However, in this embodiment, a blower B is provided for forcing a combustible mixture into the plurality of combustion chambers C'. Such blower B is adapted to be connected to a supply source (not shown) for introducing the combustible mixture into the combustion chambers C'. As shown, at times inlet valve 70 is provided in the conduit 70*a* which connects the blower B and the combustion chambers C'. The valve 70 regulates the flow of combustible gas to such chambers C'. An ignition device 116, such as a spark plug, is provided in the initial combustion chamber 111 for igniting the fuel-air mixture in such chambers C'. A suitable actuating device is provided for actuating the ignition device 116 after the inlet valve 70 has allowed a charge of combustible fuel to be placed in the chambers 111, 112, and 113.

A conduit 71 is connected to the outlet 71*a* of the chambers C' for conducting compressed gas from the chambers C' to a pressure chamber or vessel 80 which provides a means to confine pressure in the chambers C' while combustion is occurring therein to cause pressure in the succeeding chambers to progressively increase as combustion advances from a preceding to a succeeding chamber. A valve 72 is provided in the conduit 71 which may be a pressure actuated check valve or a timed valve, as desirde, for admitting pressurized gas of a predetermined minimum pressure to the pressure chamber 80. An exhaust valve 73 is also provided in the conduit 71 for exhausting residue gases from the chambers C' after combustion has occurred. Such exhaust valve 73 is preferably actuated by a timing device (not shown) which is synchronized so as to open the exhaust valve 73 while the inlet valve 70 is open and thereby allows the gas mixture introduced into the chambers C' by the blower B to expel the residue remaining therein after the ignition of the preceding charge has been completed.

As shown in the drawings, pressurized gas from the pressure vessel 80 is supplied through a conduit 81 to a turbine T for rotating the rotors thereof in a manner well known in the art. It will be appreciated that with the gas generator of this invention, one or more pressure actuated devices may be connected to the pressure vessel 80 for operation by the gas supplied therefrom.

In using the apparatus A' of this invention, the blower B may be operated either continuously or intermittently, as desired, for supplying a fuel-air mixture to the succession of combustion chambers C'. The valves 70 and 73 are normally synchronized so as to be open simultaneously to facilitate the expulsion of residue gas as well as facilitating the introduction of a fresh charge of combustible fuel. After the chambers C' have been charged with fuel, both valves 70 and 73 are closed and the ignition device 116 is actuated to ignite the combustible fuel. The expansion of the combustible charge in the chambers C' is substantially the same as that described heretofore with reference to the chambers C. The valve 72 may be a check valve or may be a timed valve, as desired; however, it functions to admit compressed gas into the pressure vessel or storage chamber 80 from whence the pressurized gas is drawn for use in operating the various pressure actuated tools or devices such as turbines, pneumatic hammers, or the like.

The foregoing disclosure and description of the invention are illustrative and explanatory thereof, and various changes in the size, shape, and materials as well as in the details of the illustrated construction may be made within the scope of the appended claims without departing from the spirit of the invention.

What is claimed is:

1. A gas compressor comprising:

(a) a housing;

(b) a plurality of interconnected chambers arranged in succession in such housing;

(c) inlet means connected to the first of said chambers for introducing a combustible charge into the plurality of chambers;

(d) a discharge means connected to the final chamber of said plurality of interconnected chambers for the discharge of the combustible charge after combustion from all of said chambers;

(e) one-way valve means between each of said chambers for permitting flow from a preceding to a succeeding chamber;

(f) means for igniting a combustible charge in said chambers;

(g) means associated with the discharge means of the final chamber for confining the combustible charge in said chambers during combustion thereof to obtain a pressure in the final chamber as a result of the combustion in the successive chambers which is greater than the pressure developed during combustion in each preceding chamber;

(h) said means associated with said final chamber for confining pressure therein includes:

(1) a pressure tank connected to said discharge means for receiving fluid under pressure from said chambers;

(2) a terminal valve in said discharge means for selectively opening and closing communication therethrough; and

(3) an exhaust valve also connected with said discharge means for exhausting residue gas from said chambers while the terminal valve is closed and a fresh combustible charge is being introduced into the chambers at the inlet means.

References Cited

UNITED STATES PATENTS

1,239,519 9/1917 Rector ---------- 60—39.68 X

FOREIGN PATENTS

7,912 1907 Great Britain.

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