

July 7, 1931.

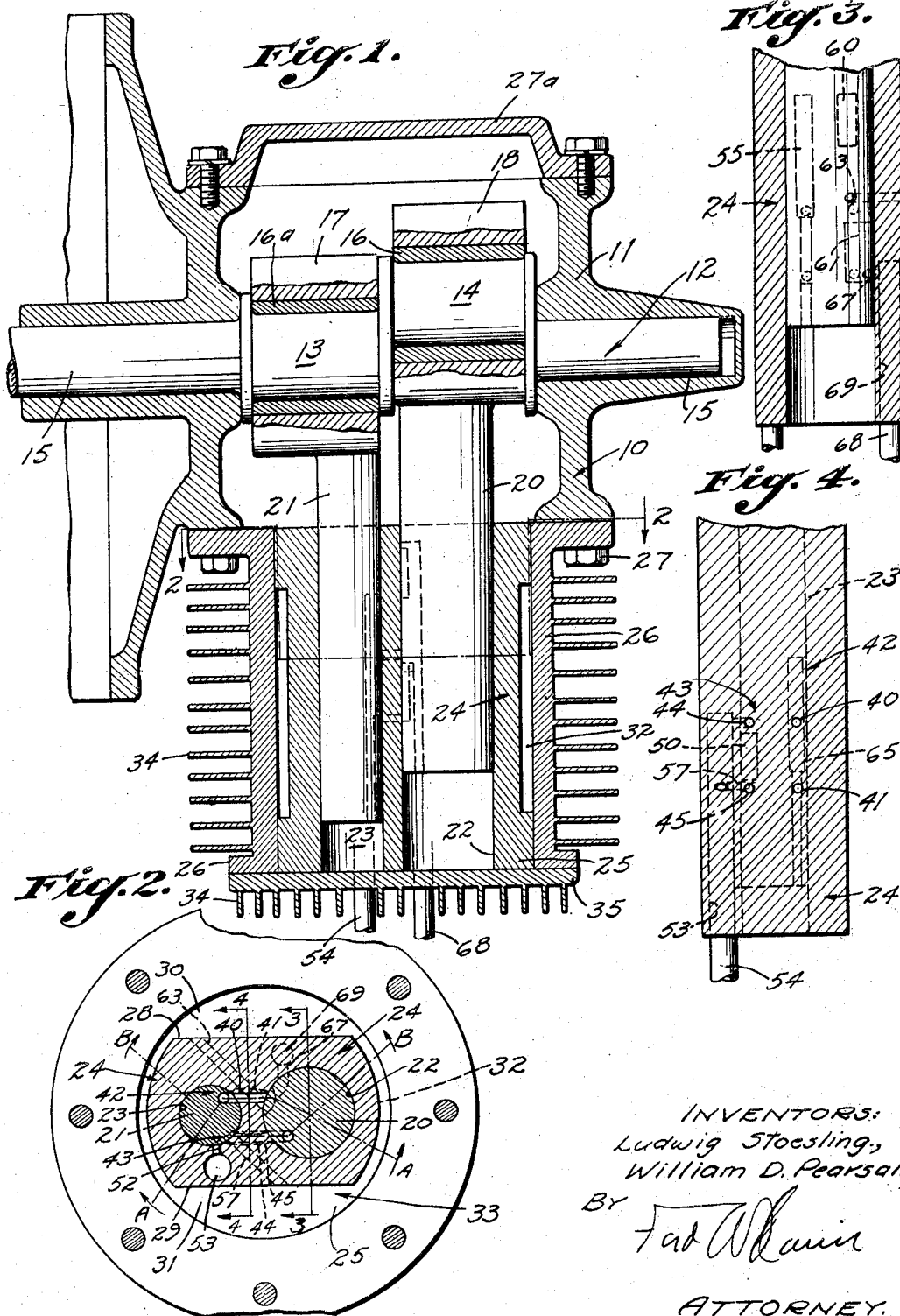
L. STOESLING ET AL

1,813,128

COMPRESSOR

Filed April 9, 1928

2 Sheets-Sheet 1



INVENTORS:
Ludwig Stoessling,
William D. Pearsall,
BY *Farmer*
ATTORNEY.

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Fig. 5. Fig. 6. Fig. 7. Fig. 8.

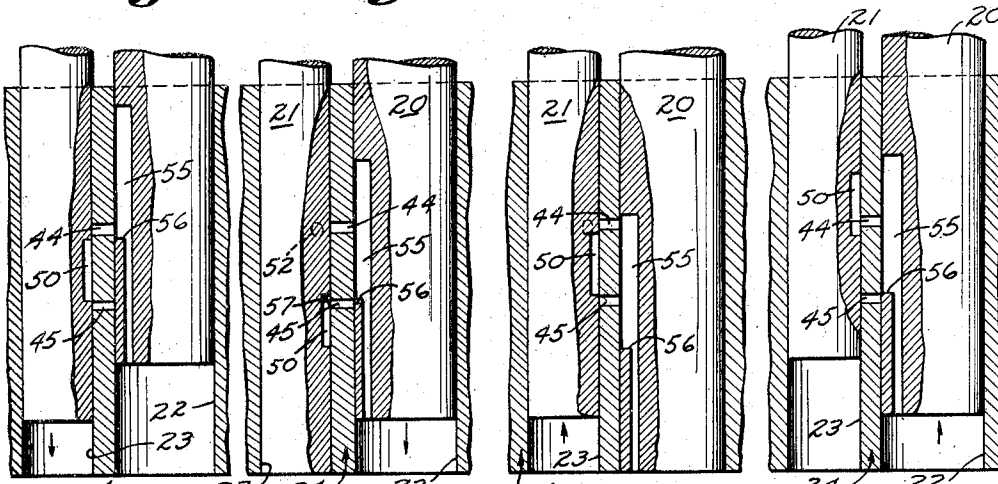
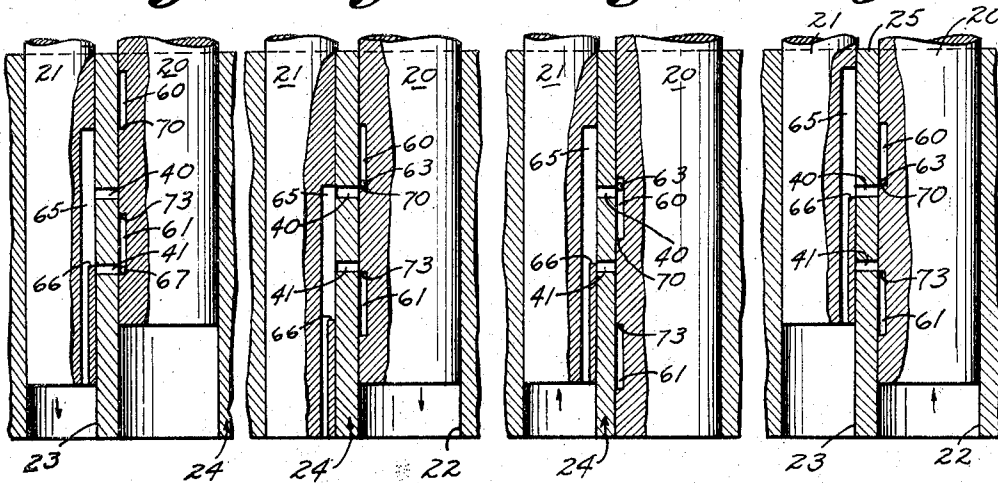


Fig. 9. Fig. 10. Fig. 11. Fig. 12.



INVENTORS:

Ludwig Stoesling,
William D. Pearsall,
BY

For Attorney

ATTORNEY.

UNITED STATES PATENT OFFICE

LUDWIG STOESLING, OF SAN FERNANDO, AND WILLIAM D. PEARSALL, OF HOLLYWOOD,
CALIFORNIA

COMPRESSOR

Application filed April 9, 1928. Serial No. 268,558.

Our invention relates to a novel mechanism for use in reciprocating machinery, and finds particular utility in the gas compressor, or internal combustion engine art. The present invention is an improvement on an invention of Ludwig Stoesling, filed August 2, 1927, Serial No. 210,062, entitled "Compressors", in which certain features disclosed in the present application are claimed.

Essentially our invention comprises a pair of cylinders, each cylinder having a piston reciprocable therein. Suitable passages are formed through the cylinder walls, these passages communicating between the two cylinders and being aligned with suitable ports in the sides of the piston. The passages and ports are so positioned that one piston and cylinder cooperate to provide an intake and exhaust mechanism for the other cylinder, this other cylinder in turn cooperating with its piston to provide an intake and exhaust means for the first cylinder. Thus, no external valves are needed. Such a construction is cheaper to build, having far less moving parts than the ordinary construction, and produces a very simple valve mechanism.

It is an object of our invention to provide a valve mechanism incorporated in the cylinder walls and in a piston reciprocated therein.

Another object of our invention is to provide a device having a pair of cylinders in which a pair of pistons reciprocates, one of these cylinders and pistons being adapted to act as a valve means for the other cylinder and vice versa.

A further object of our invention is to provide a pair of reciprocating pistons operating in cylinders, these pistons having ports adapted to register with passages through the piston walls in a manner to utilize one cylinder and piston as a valve mechanism for the other, the speed of movement of the cylinder ports relative to the passages being greatest at the instant the valve passages are opened and closed.

Our invention is applicable to reciprocating prime movers such as internal combustion engines, compressed gas engines, etc., as well as being applicable to gas compressors. The mechanism disclosed might also

be used for pumping purposes, but for the purpose of definiteness we shall particularly describe our invention in the form of a compressor, and shall more particularly describe it in relation to a carbon dioxide compressor applicable to domestic refrigeration plants. This choice is merely illustrative of one utility of our invention.

It is an object of our invention to provide a compressor for domestic refrigeration plants which is very quiet and efficient in operation and which has no external valves.

Another object of our invention is to provide a multi-stage compressor having an intercooling space into which one stage discharges and from which the other stage intakes.

Further objects and advantages of our invention will be made evident hereinafter.

Referring to the drawings,—

Fig. 1 is a vertical view, partially sectioned, of the compressor of our invention.

Fig. 2 is a view taken on the line 2—2 of Fig. 1.

Fig. 3 is a view taken substantially on the line 3—3 of Fig. 2.

Fig. 4 is a view taken substantially on the line 4—4 of Fig. 2.

Figs. 5, 6, 7, and 8 are diagrammatic views taken approximately on the line A—A of Fig. 2.

Figs. 9, 10, 11, and 12 are diagrammatic views taken substantially on the line B—B of Fig. 2.

Referring to these drawings, we illustrate a compressor 10 having a body 11 adapted to journal a crank shaft 12. This crank shaft has bearing portions 13 and 14 which are eccentric relative to end-bearing portions 15 which are journaled in the body 11.

Bearing blocks 16 and 16^a surround the bearing portions 13 and 14, these blocks being slidable in yokes 17 and 18. The bearing portions, the bearing blocks, and the yokes cooperate to form a Scotch yoke mechanism well-known in the art.

Secured respectively to the yokes 18 and 17 are primary and secondary pistons 20 and 21 which are adapted to be reciprocated in primary and secondary cylinders 22 and 23.

These cylinders are formed in an inner member 24 having circular end-members 25 which engage the inner walls of a cylinder casing 26. This cylinder casing is suitably secured to the body 11 as by bolts 27, the opposite end of the body being closed by a cover plate 27^a suitably secured thereto.

Due to the Scotch yoke connection between the pistons and the crank shaft, these pistons move in the cylinders with simple harmonic motion. The bearing portion 13 is disposed 90° ahead of the bearing portion 14 so that the primary and secondary pistons reciprocate in their respective cylinders out of phase with each other, the secondary piston 21 leading the primary piston 20 by a phase displacement of 90° on the crank shaft.

The central portion of the inner member 24 has parallel walls 28 and 29 which define spaces 30 and 31 between these walls and the inner wall of the cylinder casing 26. The spaces 30 and 31 are connected by means of annular chambers 32 formed between the end-members 25. The annular chambers 32 and the spaces 30 and 31 cooperate to form an intercooling chamber 33, this chamber being adapted to receive the gases exhausted from the primary cylinder 22, and to supply intake gas to the secondary cylinder 23 in a manner to be described. Suitable fins 34 extend outward from the cylinder casing 26 and from a head 35 closing the end of the cylinder casing. These fins have large surfaces exposed to the air and act as a cooling means for the gas in the intercooling chamber 33. It is, of course, well-known that better results are obtained from a multi-stage compressor when intercooling means is provided for the gases between stages.

No external valves are utilized in our compressor, the valve action taking place through the cooperation of the pistons and the cylinders. Briefly stated, we utilize the primary cylinder and piston as a valve means for the secondary piston and cylinder, and vice versa.

In accomplishing this result, we provide four passages through the inner member 24, these passages communicating between the primary and secondary cylinders 22 and 23. These passages are adapted to successively register with certain ports formed on the primary and secondary pistons. For the purpose of clearness, these ports and passages have been divided into two groups, passages 40 and 41 forming a portion of a main group 42, and passages 44 and 45 forming a portion of an auxiliary group 43. Hereinafter we shall particularly designate the passages 40 and 41 as being intake and exhaust passages of the main group. Similarly, passages 44 and 45 will hereinafter be designated as intake and exhaust passages of the auxiliary group. The passages 40 and 44 are disposed vertically above the passages 41 and 45, but for pur-

poses of clearness the passages 41 and 45 have been shown slightly curved in Fig. 2.

The secondary piston 21 has a valve port 50 therein, this port forming a portion of the auxiliary group so as to successively register with the intake and exhaust ports 44 and 45 when the secondary piston is reciprocated in the secondary cylinder. The valve port 50 is also adapted to come into registration with a passage 52 during the time that this port is in communication with the intake passage 44. This passage 52 is in communication with a low pressure intake passage 53 which extends outward through the inner member 24 and is in communication with an intake pipe line 54 extending from the head 35.

The primary piston 20 is provided with a piston port 55 which communicates with the compression space of the primary cylinder 22 through an opening extending longitudinally in the primary piston. The piston port 55 has a shoulder 56 which closes the exhaust port 45 when the primary piston is in the retracted half of its stroke. This piston port 55 is sufficiently long so that it never covers the intake port 44.

During the time that the valve port 50 is in communication with the exhaust passage 45 this port is also in communication with an intermediate exhaust passage 57 which also communicates with the intercooling chamber 33.

The cooperation between the ports and passages of the auxiliary group may best be understood by reference to Figs. 5 to 8 inclusive; these figures diagrammatically illustrating the piston and auxiliary valve group positions for each 90° of rotation of the crank shaft. Thus, Fig. 7 illustrates the primary piston 20 in its extreme advanced position, while the secondary piston 21 is in an intermediate position moving at its maximum speed in the direction indicated by the arrow. At this instant the valve port 50 is just coming into communication with the intake passage 44, this passage being in communication with the port 55. Thus, as the primary piston is moving toward a position indicated in Fig. 8, gas is drawn through the low pressure intake passage 53 and the passage 52, this gas passing through the valve port 50 and the intake passage 44 reaching the port 55 whence it is conducted to the primary cylinder.

When the mechanism is in the position shown in Fig. 8, the secondary piston 21 is in its retracted position, and the primary piston is in a mid-position. When the primary and secondary pistons reach a position indicated in Fig. 5, the primary cylinder will have received a full charge of gas, this charge being stopped when the valve port 50 closes the intake passage 44 at the instant indicated in Fig. 5. The primary piston at this instant is in its extreme retracted position and the primary cylinder is completely filled with gas.

As the primary piston advances, this gas is compressed until the pistons reach a position indicated in Fig. 6. In this figure, the primary piston has reached a mid-position and is travelling at its maximum speed while the secondary piston is in its extreme advanced position. At this instant the shoulder 56 of the piston port 55 uncovers the exhaust passage 45, allowing the gas, compressed to substantially twice its normal pressure, to escape through the exhaust passage 45, through the port 50 now in communication with this passage, and through the intake and exhaust passage 57 whence this gas reaches the intercooling chamber 33. The piston port 55 remains in registration with the exhaust passage 45 throughout the remainder of the stroke of the primary piston so that all the compressed gas therein is pushed outward into the intercooling chamber 33.

The main group of ports and passages, together with the cooperation therebetween will now be described. This main group includes a pair of longitudinally aligned ports 60 and 61 formed on the primary piston 20, these ports being adapted to successively register with intake and exhaust ports 40 and 41 and being termed intake and exhaust valve-ports respectively for purposes of identification. The intake valve-port 60 also comes into registration with an intermediate intake passage 63 which communicates with the intercooling chamber 33. This registration of the intake valve-port 60 and the intermediate intake passage 63 takes place when the primary piston is in a relatively advanced position as will be explained. The gases entering the intermediate intake passage 63 and passing through the intake valve-port 60 and intake passage 40 are conducted to the secondary cylinder 23 by a port 65 which is in communication with this cylinder through an opening extending longitudinally in the secondary piston 21.

This port has a shoulder 66 which is adapted to close the exhaust passage 41 until the secondary piston reaches its mid-position at which time the compressed gases may escape through the passage 41 and into the port 61 of the primary cylinder. At this time this port 61 is in communication with an outlet passage 67, this passage communicating with a high pressure exhaust line 68 by means of a high pressure exhaust passage 69.

The operation of the main group of ports and passages is thus as follows:

Referring particularly to Fig. 10, the secondary piston is shown in an advanced position while the primary piston 20 is in a mid-position and moving at its fastest speed. At this instant the intake valve-port 60 uncovers the intermediate intake passage 63, allowing the gas in the intercooling chamber 33 to reach the port 60. Also at this instant

a shoulder 70 of the port 60 is just opening the intake passage 40 so that this gas may communicate with the secondary cylinder through the intake passage 40 and the port 65. Gas is thus drawn into the secondary cylinder during the time that the secondary piston is moving into retracted position.

Fig. 11 illustrates a mid-position of the secondary piston 21, the primary piston 20 at this instant being in an extreme advanced position, at which time the port 60 still registers with the intake port 40 to allow gas to enter the secondary cylinder 23.

When the primary piston 20 reaches this mid-position, the shoulder 70 closes the intake passage 40, the secondary piston at this time being in extreme retracted position. The pistons then move toward their position indicated in Fig. 9, the secondary piston compressing the gas until this piston reaches its mid-position, at which time the shoulder 66 of the port 65 uncovers the exhaust passage 41. The exhaust valve-port 61 at this time is in communication with the exhaust passage 41 and also with the passage 67 so that the compressed gas is forced outward through the high pressure line 68 as the secondary piston continues to move into an advanced position. When in this advanced position, a shoulder 73 of the exhaust valve-port 61 closes the exhaust passage 41 at the same instant that the shoulder 70 opens the intake passage 40.

It should thus be clear that we utilize one piston and cylinder as a valve mechanism for the other, and vice versa, at the same time achieving the normal compression from each of these cylinders.

It should, of course, be understood that we are not limited to a two-stage compressor. Each of the pistons and cylinders might act to independently supply a compressed gas to a high pressure exhaust line, utilizing the cooperation between one piston and its cylinder as a valve means for the other.

It should further be understood that we are not limited to the valves opening at the particular instant described. A compression to a half-stroke has been found advantageous in compressing the sulphur dioxide for use in domestic refrigeration plants, but other installations will possibly require a slightly different placement of the ports and passages so that compression over a greater or lesser portion of the stroke is accomplished.

The intercooling chamber 33 acts both as a reservoir between the two stages and also as an intercooler for cooling gas before this gas is further compressed in the succeeding stage. Any or no method of cooling this chamber may be utilized without departing from the spirit of our invention. In fact, no intermediate chamber need be used where both pistons are acting independently to each produce the maximum pressure in the exhaust line.

We are furthermore not limited to a two-stage compressor. It should be obvious that our idea may be incorporated in a compressor or engine having any number of stages or cylinders.

We claim as our invention:

1. In a device of the class described, the combination of: walls forming primary and secondary cylinders; a primary piston reciprocable in said primary cylinder; and a secondary piston reciprocable in said secondary cylinder, said primary piston and said walls of said primary cylinder providing co-acting means forming an intake and exhaust means for said secondary cylinder, and said secondary piston and said walls of said secondary cylinder providing co-acting means forming an intake and exhaust means for said primary cylinder.

2. In a device of the class described, the combination of: walls forming primary and secondary cylinders; a primary piston reciprocable in said primary cylinder; a secondary piston reciprocable in said secondary cylinder; and means for reciprocating said primary and said secondary pistons with a constant phase displacement therebetween, said primary piston and said walls of said primary cylinder providing coacting means forming an intake and exhaust means for said secondary cylinder, and said secondary piston and said walls of said secondary cylinder providing co-acting means forming an intake and exhaust means for said primary cylinder.

3. In a device of the class described, the combination of: walls forming primary and secondary cylinders, said walls having passages therein communicating with said cylinders; a primary piston reciprocable in said primary cylinder and having ports in the sides thereof adapted to register with certain of said passages during said reciprocation; a secondary piston reciprocable in said secondary cylinder and having ports in the sides thereof adapted to register with certain of said passages during said reciprocation; and means for reciprocating said pistons in a manner to align the ports of one piston with certain of said passages to form an intake and exhaust means for the other piston, and vice versa.

4. In a device of the class described, the combination of: walls forming primary and secondary cylinders, said walls having passages therein communicating with said cylinders; a primary piston reciprocable in said primary cylinder; and a secondary piston reciprocable in said secondary cylinder, said primary and said secondary pistons having ports therein, said ports and said passages being disposed in two groups, the ports and passages of one group coming into registration to permit intake to and exhaust from one of said cylinders, and the ports and pas-

sages of the other group coming into registration to permit the intake to and exhaust from the other of said cylinders.

5. A combination as defined in claim 4 in which said ports and passages are positioned to come into registration when the speed of said secondary piston is a maximum.

6. A combination as defined in claim 4 in which each of said groups includes an intake and an exhaust passage adapted to come into registration with ports on both of said pistons forming a part of said groups.

7. A combination as defined in claim 3 in which one port on said primary and on said secondary pistons communicates respectively with said primary and secondary cylinders through said pistons.

8. A combination as defined in claim 4 in which each of said groups includes an intake and an exhaust passage, and in which one port on said secondary piston practically simultaneously opens and closes intake and exhaust passages respectively of one of said groups, and in which said primary piston includes a pair of ports which practically simultaneously open and close intake and exhaust passages respectively of the other of said groups.

9. A combination as defined in claim 1 including means for reciprocating said pistons with a phase displacement of ninety degrees.

10. In a device of the class described, the combination of: a cylinder casing; an inner member in said cylinder casing and providing primary and secondary cylinders, there being an intercooling chamber between said casing and said inner member; primary and secondary pistons reciprocable in said primary and secondary cylinders; walls forming a passage for conducting the exhaust gases from said primary cylinder into said intercooling space; and walls forming a passage for conducting gas in said intercooling space into said secondary cylinder.

11. In a device of the class described, the combination of: a cylinder; a piston reciprocable in said cylinder to define a variable-volume compression space, said piston providing a passage communicating with said compression space and through which gases entering and leaving said compression space must flow; a valve means for controlling the gas supplied to and discharged through said passage; and means for moving said piston and said valve means.

12. In a device of the class described, the combination of: walls defining an intercooling chamber; walls defining primary and secondary cylinders; primary and secondary pistons respectively reciprocable in said primary and secondary cylinders; walls defining a low pressure intake passage communicating with said secondary cylinder; walls defining an intermediate exhaust passage communicating between said secondary cylinder

and said intercooling chamber; walls defining main and auxiliary groups of passages communicating between said primary and secondary cylinders; each group comprising an intake and an exhaust passage; walls defining a valve port on said secondary piston and adapted to interconnect said intake passage of said auxiliary group and said low pressure intake passage and to subsequently interconnect said exhaust passage of said auxiliary group and said intermediate exhaust passage; walls defining a piston port on said primary piston communicating with the compression space of said primary cylinder, said piston port coming into registry with said intake and exhaust passages of said auxiliary group when said primary piston is reciprocated; walls defining an intermediate intake passage communicating between said intercooling chamber and said primary cylinder; walls defining an intake valve-port formed on said primary piston and adapted to interconnect said intake passage of said main group and said intermediate intake passage during the reciprocation of said primary piston; walls defining an outlet passage communicating with said primary cylinder; walls defining an exhaust valve-port formed on said primary piston and adapted to interconnect said exhaust passage of said main group and said outlet passage during the reciprocation of said primary piston; walls defining a piston port on said secondary piston adapted to register with said intake and exhaust passages of said main group during the reciprocation of said secondary piston, said piston port communicating with the compression space of said secondary cylinder; and means for reciprocating said pistons in said cylinders.

13. In a device of the class described, the combination of: walls forming primary and secondary cylinders, said walls including inter-communicating means communicating with said cylinders; a primary piston reciprocable in said primary cylinder; and a secondary piston reciprocable in said secondary cylinder and including a port adapted to register with said inter-communicating means and through which both the intake and exhaust gas of said primary cylinder passes.

14. In a device of the class described, the combination of: walls defining primary and secondary cylinders; walls forming intake and exhaust passages communicating between said cylinders; walls forming intake and exhaust means communicating with said secondary cylinder; a primary piston reciprocable in said primary cylinder and cooperating therewith in defining a compression space communicable with said intake and exhaust passages; and a secondary piston reciprocable in said secondary cylinder and providing a port positioned to inter-connect said intake passage and said intake means

during one portion of the stroke of said primary piston and to inter-connect said exhaust passage and said exhaust means during another portion of said stroke.

15. In a device of the class described, the combination of: walls forming primary and secondary cylinders inter-connected by passages; a primary piston in said primary cylinder and cooperating therewith in providing a compression space, said primary piston including a piston port communicating with said compression space and positioned to register with said passages; a secondary piston in said secondary cylinder and providing a valve port positioned to successively register with said passages to control the flow of gas therethrough; and means for moving said valve port into successive registration with said passages during the registration therewith of said piston port.

16. In a device of the class described, the combination of: walls forming a primary cylinder; walls forming intake and exhaust passages communicating with said cylinder; a piston reciprocable in said cylinder and cooperating therewith in providing a compression space, said piston including a port communicating with said compression space and positioned to register with said intake and exhaust passages during the movement of said piston; and valve means for supplying gas to said intake passage at a time when said port is in registration with said intake passage and for conducting gas from said exhaust passage at a time when said port is in registration with said exhaust passage.

17. In a device of the class described, the combination of: walls forming a primary cylinder; walls forming intake and exhaust passages communicating with said cylinder; a piston reciprocable in said cylinder and cooperating therewith in providing a compression space, said piston including a relatively long port communicating with said compression space, said port being long enough to register with both of said passages when said piston is in an advanced position and providing a shoulder moving into closing relationship with said exhaust passage when said piston is moving toward its advanced position; and valve means operated with a constant phase displacement with respect to said piston for controlling the gas passing through said passage.

18. In a device of the class described, the combination of: walls forming a primary and a secondary cylinder; walls forming intake and exhaust passages communicating between said cylinders; walls forming intake and exhaust means communicating with said primary cylinder; a secondary piston in said secondary cylinder and cooperating therewith in forming a compression space, said secondary piston including a piston port adapted to register with said passages during

a movement of said secondary piston and communicating with said compression space; and a piston in said primary cylinder and providing a pair of valve ports so disposed that one of said valve ports inter-connects said intake passage and said intake means during the movement of said secondary piston in one direction, and the other of said valve ports inter-connects said exhaust passage and said exhaust means during a movement of said secondary piston in an opposite direction.

19. In a device of the class described, the combination of: primary and secondary cylinder walls defining primary and secondary cylinders; a primary piston in said primary cylinder; a secondary piston in said secondary cylinder; walls defining an inter-cooling space adjacent said cylinders; walls defining a gas supply means communicating with said secondary cylinder, there being means formed on said secondary cylinder walls and said secondary piston for conducting gas from said gas supply means to said primary cylinder where it is compressed, there being means formed on said secondary cylinder walls and said secondary piston for conducting the compressed gas to said intercooling space; walls forming an intermediate intake passage communicating with said inter-cooling space and with said primary cylinder, there being means formed on said primary cylinder walls and said primary piston for conducting the compressed gas flowing through said intermediate intake passage to said secondary cylinder where it is further compressed, there being means formed on said primary cylinder walls and said primary piston for conducting said further compressed gas from said device.

20. In a device of the class described, the combination of: walls defining a primary and a secondary cylinder; walls forming an inter-communicating means opening on said cylinders and through which gas is supplied to and exhausted from said primary cylinder; walls forming an intake and exhaust means communicating with said primary cylinder; a primary piston reciprocable in said primary cylinder and providing a piston port positioned to register with said inter-communicating means during the stroke of said primary piston, said piston port communicating with a compression space bounded by the walls of said primary cylinder and said primary piston; a secondary piston reciprocable in said secondary cylinder and providing a valve port successively connecting said intake and said exhaust means to said inter-communicating means; and means for maintaining the phase displacement of said primary and secondary pistons constant.

21. In a device of the class described, the combination of: walls forming a primary cylinder; walls forming an intake and an

exhaust passage communicating with said primary cylinder; a piston in said cylinder and cooperating therewith in providing a compression space, said piston providing a port communicating with said compression space, said port registering with said passages and being sufficiently long to never cover one of said passages but providing a shoulder adapted to cover the other of said passages during a portion of the stroke of said piston; and valve means for controlling the supply of gas to said one of said passages, said shoulder controlling the flow through the other of said passages.

In testimony whereof, we have hereunto set our hands at Los Angeles, California, this 5th day of April, 1928.

LUDWIG STOESLING.

WILLIAM D. PEARSALL.

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