H. COOPER.

GAS ENGINE.

APPLICATION FILED DEC. 2, 1910.

1,018,481.

Patented Feb. 27, 1912.

2 SHEETS—SHEET 1.

Fig. 1

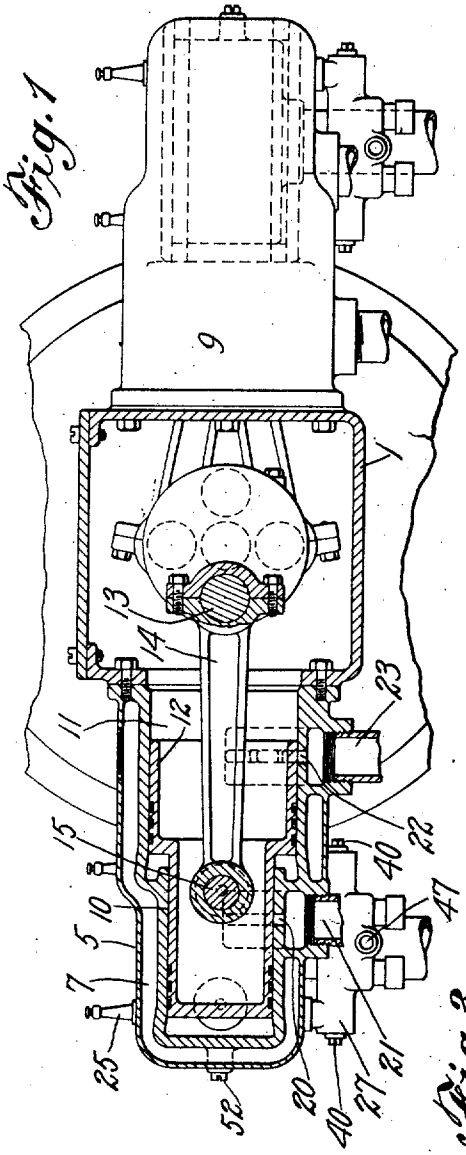


Fig. 4

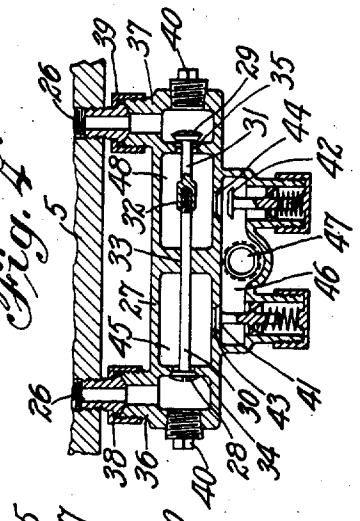
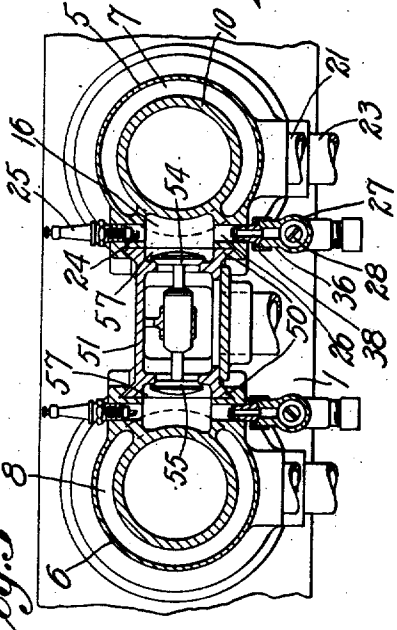


Fig. 3



Attest

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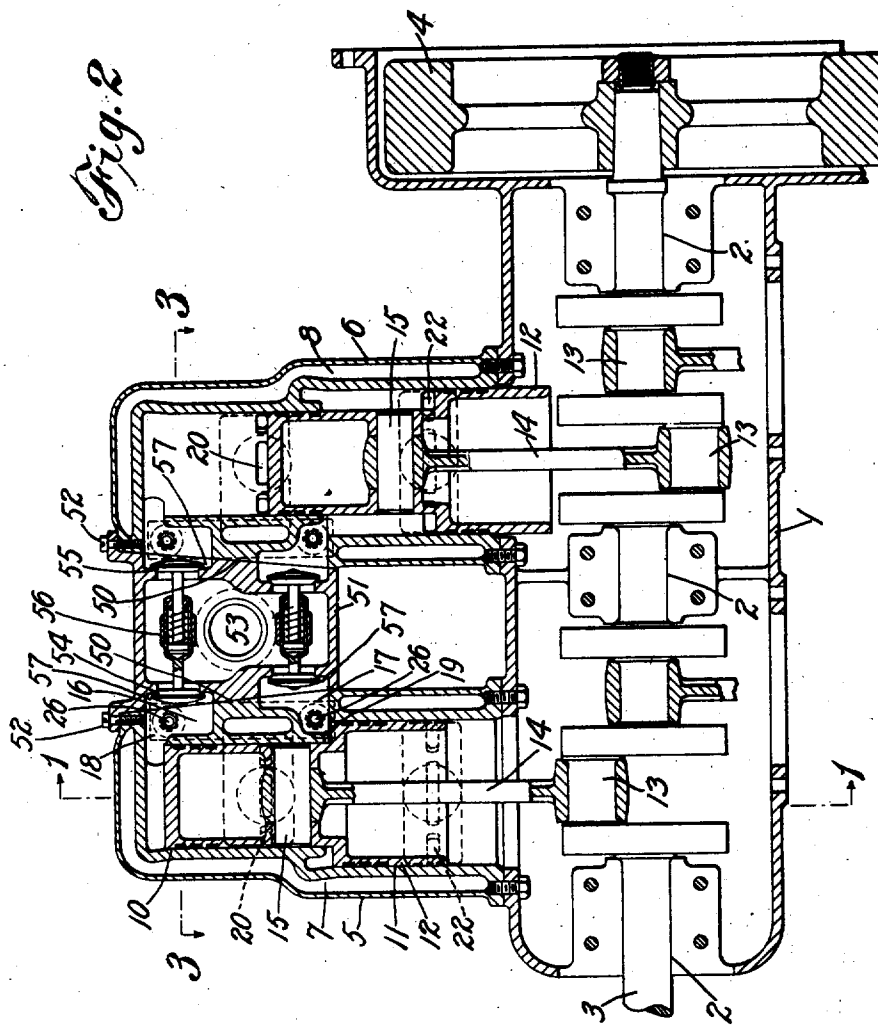
2 SHEETS—SHEET 2.

Fig. 2



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UNITED STATES PATENT OFFICE.

HERBERT COOPER, OF BROOKLYN, NEW YORK.

GAS-ENGINE.

1,018,481. Specification of Letters Patent. Patented Feb. 27, 1912.

Application filed December 2, 1910. Serial No. 595,201.

To all whom it may concern:

Be it known that I, HERBERT COOPER, a citizen of the United States, residing at Brooklyn, county of Kings, and State of New York, have invented a new and useful Improvement in Gas-Engines, of which the following is a specification.

This invention relates to an improvement in gas engines, particularly to the kind used in driving automobiles and boats. There are two general types of gas engines in use for this purpose. The so-called "two-cycle" engines are operated without the use of valve mechanism, and are simple in construction. Engines of the so-called "four-cycle" type require valve mechanism in their operation, and are comparatively complicated in construction. Considerable difficulty is experienced with both types in keeping them up to their rated efficiency. This is partly due to the fact that all the burned gas remaining in the cylinders after an explosion is not removed before a fresh charge of gas is introduced into the cylinder. This defect is more prominent in the two-cycle engine than in the four-cycle engine, but in the latter the percentage of burned gas remaining in the cylinder is excessive and interferes seriously with the efficiency of the engine. The high speed at which the present engines are ordinarily run results in rapid and excessive wear of the valve mechanism and other parts, and derangement of the various parts frequently occurs. Moreover, unskilful handling of such engines frequently results in improper adjustment of the engine parts and operating mechanism, and consequent inefficient operation.

It is highly desirable that a gas engine should run constantly at its highest possible degree of efficiency for upon this efficiency economy of operation depends, and upon economy of operations depends the success of the engine for commercial purposes. It is also highly desirable that such engines should be so constructed that complicated mechanism is avoided without sacrificing any of the advantages of the present engines. It is further desirable that the valve mechanism of such engines should be so constructed that readjustment is unnecessary and tampering practically impossible.

It is one of the objects of the present invention, therefore, to produce a gas engine in which the percentage of burned gas remaining in the cylinders after an explosion is reduced to a minimum.

A further object is the production of an engine in which the valve mechanism is very simple, free from the excessive wear found in present engines, and completely housed so that unskilful handling and tampering are impossible.

A further object is the production of an engine in which the valve mechanism is operated automatically by the pressure set up in the cylinders during the gas compression period.

Still another object is the production of a valve mechanism which is self contained and may be removed from the engine without disturbing any adjustment thereof, and which also serves as a tie or stay between the cylinders.

With these and other objects not specifically mentioned in view, the invention consists in certain constructions and combinations which will be hereinafter fully described and then specifically pointed out in the claims hereunto appended.

In the accompanying drawings which form a part of this specification and in which like characters of reference indicate the same or like parts, Figure 1 is an elevation, partly sectional, of a multi-cylinder gas engine of the horizontal opposed cylinder type constructed in accordance with the invention, Fig. 2 is a sectional plan view of the structure shown in Fig. 1 with one set of cylinders omitted, Fig. 3 is a section taken on the line 3—3 in Fig. 2, and Fig. 4 is an enlarged sectional view of one of the scavenging relief valves and its connections.

In carrying the invention into effect, there is provided a pair, or in certain constructions more than one pair, of cylinders, and these cylinders may vary within wide limits. The device selected to illustrate the invention is a multi-cylinder engine of the tandem opposed cylinder type, but it is to be clearly understood that the invention may be embodied in any type of engine where two, or a multiple of two, cylinders are used. As shown, there is provided a crank case 1 having bearings 2 in which a crank shaft 3 is journaled in a well known manner. The crank shaft 3 projects beyond the crank case and upon its projecting end, a fly wheel 4 is secured. Upon one side of the crank case 1 are mounted two tan-

dem cylinder castings 5 and 6, bolted to the case and provided with water jackets 7 and 8 of well known construction, each casting inclosing a pair of tandem cylinders. Similarly, upon the opposite side of the crank case, like cylinders 9, only one of which is shown, are mounted. It may be here remarked that all of the cylinders are alike, except that their intake ports are oppositely positioned, and a description of one, in connection with the drawings, is deemed sufficient to enable their construction to be fully understood. The cylinder casting 5 is bored to form two tandem cylinders 10 and 11 within which a single acting piston 12 works. This piston, like the cylinders, is of two different diameters, and it is to be understood that the effective area of the two piston heads is equal, so that the impulses of the piston are equal as charges are alternately exploded in the cylinders behind it. The piston is connected with the crank 13 of the shaft 3 by means of a connecting rod 14 pivoted on a pin 15 within the piston in the usual manner. The cylinder 10 is provided, at a point adjacent its head, with an intake chamber 16. Similarly, the cylinder 11 is provided with an intake chamber 17. A passage 18 affords open communication between the intake chamber 16 and the interior of the cylinder 10, and a passage 19 affords open communication between the intake chamber 17 and the interior of the cylinder 11. The cylinder 10 is provided with an exhaust port 20 cut through its wall and leading to an exhaust pipe 21. Similarly, the cylinder 11 is provided with an exhaust port 22 cut through its wall and leading to an exhaust pipe 23. The intake chamber 16 is provided with a threaded aperture 24 in which a spark plug 25 is screwed. All the intake chambers of all the cylinders are similarly provided with like apertures and spark plugs. The construction so far described does not differ materially from other constructions well known in the art, and since the operation of such structures is well understood, and since a more detailed description of the several cylinders is not necessary to a full understanding of the present invention, it is omitted in the interest of clearness and brevity.

When a charge of gas within one of the cylinders is fired, the piston is driven toward the crank shaft by the impulse of the exploded gas. This impulse and movement continue until the piston has traveled far enough to open the exhaust port in the wall of the cylinder. The greater part of the burned gas then escapes through the wall exhaust port. As the piston travels back toward the cylinder head, the exhaust port is closed and a portion of the burned gas is trapped in the cylinder. This gas has lost its impulse producing power, but if permitted to remain within the cylinder will foul the next charge and reduce the efficiency thereof. If cleared out by incoming fresh gas, as in certain two-cycle engines, the desired result is obtained by a waste of fresh gas which is fatal to economical operation. If cleared out by means of mechanically operated exhaust valve mechanism, as in certain four-cycle engines, a percentage of burned gas too great for economical operation remains in the cylinder, and the excessive wear of the valve mechanism contributes to the inefficiency of the engine from an economical commercial standpoint. It is very important that the burned gas be expelled without waste of fresh gas, and without the employment of complicated valve mechanism subject to excessive wear, breakage and derangement. Each cylinder is therefore provided with what may be termed a scavenging port through which the burned gas is expelled during the return stroke of the piston. While, in certain constructions within the invention, this port may be located in the head of the cylinder, and the clearance between the piston and cylinder heads reduced to a minimum, in the device selected to illustrate the invention, each cylinder is provided with a scavenging port 26 cut through the wall of the intake chambers 16 and 17 before referred to, opposite the spark plugs 25, and adjacent the cylinder head.

Automatically operated valve mechanism is employed in connection with the scavenging ports, whereby burned gas trapped in the cylinders during the return stroke of the pistons, is expelled, and this mechanism may vary within wide limits, and be variously mounted. In the best constructions, for the purpose of housing the valve mechanism to prevent tampering therewith and to prevent accidental injury thereto, a casing is employed. While this casing may in certain constructions be formed in the cylinder casting itself; in the device shown, a casing 27 is employed, and this casing is spaced from and lies below the cylinders with its axis parallel with the axis of the cylinders. It is to be understood, however, that when a casing is employed, the parallelism of the axes of the casing and cylinders is not essential and is used in the device shown merely because it happens to be the most convenient for the type of engine used to illustrate the invention. As shown, the valve mechanism consists in a pair of valves 28 and 29 rigidly connected by means of the stems 30 and 31, which stems are screwed together at 32. The stem 30 is arranged to slide in a bearing 33 formed within the casing. The valve 28 coöperates with a valve seat 34, and the valve 29 coöperates with a valve seat 35 also formed within the

casing. These valves control the scavenging ports 26; that is to say, they control the flow of gas through the ports, and are arranged and adapted to always leave one port open.

For the purpose of operating the valve mechanism to alternately open the scavenging ports of the cylinders, connections are provided between the valve mechanism and the cylinders whereby pressure within one cylinder operates the valve mechanism to open the port of the other cylinder to permit the escape of trapped gas therefrom, and these connections may vary within wide limits. As shown, pipe connections are employed so that gas under pressure within one cylinder will act directly upon the valve mechanism to throw the valves, one to closed position and the other to open position. These pipe connections consist in bosses 36 and 37 projecting upwardly from the body of the casing 27, and unions 38 and 39 connecting the bosses with the scavenging ports 26. This construction provides an always open passage from each cylinder to the interior of the casing outside the valves, and it will be readily understood, by an inspection of Fig. 4, that gas pressure within the pipe connection at the left of the figure will drive the valve mechanism to the position shown, closing the passage from the left port to the interior of the casing between the valves, and opening the passage from the right port to the interior of the casing between the valves. The ends of the casing are provided with apertures closed by screw plugs 40. The only function of these plugs is to afford access to the interior of the casing so that the valve mechanism may be inserted therein.

Mechanism is provided for preventing intake of air through the scavenging ports after burned gas has been expelled, and this mechanism may vary within wide limits. In the best constructions, a check valve mechanism will be used for this purpose. As shown, two spring pressed check valves 41 and 42 are employed. These valves operate independently, and independent of the port controlling valve mechanism. The check valve 41 coöperates with a valve seat 43, and the check valve 42 coöperates with a valve seat 44, both of which seats are formed in the wall of the casing 27 below the port controlling valve mechanism. The check valve 41 controls the passage from what may be termed a valve chamber 45 to an outlet chamber 46 having an outlet 47 open to the atmosphere. Similarly, the check valve 42 controls the passage from a valve chamber 48 to the outlet chamber 46. It will be noted that the check valve mechanism lies between the outlet 47 and the port controlling valve mechanism. This, however, is not essential. In certain constructions, it may lie between the port controlling valve mechanism and the scavenging ports, but in all cases it will lie between the outlet and scavenging ports.

The operation of the device so far described is as follows: Assuming that a charge has just been fired in the cylinder 11, the piston common to both cylinders 10 and 11 will be driven inward toward the crank shaft 3. At this time, the smaller part of the piston coöperating with the cylinder 10 is drawing fresh gas into the cylinder 10 through the intake chamber 16 and port 18 before referred to. The intake valve mechanism will be hereinafter fully described. When the piston has traveled far enough to open the wall exhaust port 22, the greater part of the burned gas within the cylinder 11 will escape. At the same time, a small quantity of free air will be admitted through the wall exhaust port 20 to the cylinder 10, now completely filled with a fresh charge. As the piston travels on its return stroke, the fresh charge of heavy mixture will be compressed in the cylinder 10. This pressure will be communicated through the scavenging port 26 at the left, Fig. 4, to the interior of the casing 27 outside the valve 28. This pressure will throw the valves 28 and 29 to the position shown, and there hold them. This opens a passage for the light burned gas through the right scavenging port 26, from the cylinder 11 to the outlet chamber 46 and outlet 47, the check valve 42 being automatically opened by the moving burned gas. When the piston has completed its return stroke, the fresh charge in the cylinder 10 is completely compressed and ready for firing, and the cylinder 11 is ready to receive a new charge. The charge in cylinder 10 is now fired, and the piston again starts toward the crank shaft, the pressure of the exploded gas still holding the valve 28 against its seat and the valve 29 open. The piston is now drawing a fresh charge into the cylinder 11. The scavenging port of this cylinder is open, but the check valve 42 has closed and prevents intake of air through the port 26 while the charge is being drawn into the cylinder. It will be noted and readily understood from the foregoing that an explosion takes place in each of the tandem cylinders at every revolution of the crank shaft, that the action of the valve mechanism is entirely automatic and dependent only upon the pressure within the cylinders, and that the valve mechanism itself is extremely simple, thoroughly protected and highly efficient.

It is highly desirable, in an engine used for motive power, that its construction be as light as possible without sacrificing strength and rigidity. Heretofore, in the construction of multi-cylinder engines, it has been customary to tie the cylinders together, either

with a heavy casting including all the cylinders, or by means of a system of stays or braces. In both cases, the valve mechanisms for the cylinders have been independently mounted upon the frame, and independent adjustments thereof have been necessary. Furthermore, a portion at least of the valve mechanisms have been exposed and are liable to injury due to breakage or derangement. For the purpose of providing a tie for the cylinders which shall be light but strong and serve also as a housing for the valve mechanism, eliminating entirely the necessity for independent adjustment of the valves and the liability to injury, a pair of cylinders is employed having oppositely disposed abutments, and between these abutments is located a chambered block containing the valve mechanism and an intake passage controlled by the valve mechanism, the block being adapted to engage the abutments in such a way as to tie the cylinders rigidly together. These abutments and the block may vary within wide limits. As shown, however, each of a pair of cylinders is provided with a converging abutment 50 provided with a dovetail slideway, Figs. 2 and 3. These abutments cross the intake chambers 16 and 17 before referred to, and the chambers and ports 18 and 19 provide passages through the abutments to the interior of the cylinders, or what may be termed abutment ports. There is provided a chambered block 51 having converging sides engaging the dovetail slideways of the abutments and thereby holding the cylinders in rigid spaced relation to each other. The block is held in position by means of screws 52 threaded into the cylinder castings, or by equivalent means. It is of course to be understood that the abutments may in certain constructions be parallel. The chamber within the block is provided with an inlet opening 53 through which mixture reaches the chamber from a suitable source of supply not shown. The block is provided with a port or ports adapted to register with the abutment port or ports, and these ports may vary within wide limits. As shown, however, a pair of tandem cylinders are used and when a pair of tandem cylinders are used, there is provided a plurality of sets of ports in communication with the chamber of the block and adapted to register with a plurality of oppositely positioned abutment ports.

Valve mechanism controlling the block ports is provided, and this mechanism may vary within wide limits. When however, and as shown, cylinders having oppositely positioned intake ports are employed, the valve mechanism consists in a pair of spring connected valves 54 and 55, or a plurality of sets of such valves, the valve stems being guided in a bearing or bearings 56 formed in the interior of the chambered block. By an inspection of Fig. 2, it will be readily understood that a partial vacuum produced within either one of a pair of cylinders will open the valve nearest the cylinder against the action of the spring connecting it with the other valve and draw mixture through the port from the chambered block to the cylinder.

For the purpose of permitting the withdrawal of the block without in any way disturbing the valve mechanism, the block is provided with external recesses 57 registering with the block and abutment ports. The valves lie in these recesses and within the limits of the block, and come away with the block when the latter is withdrawn from its position. This permits ready access to the intake ports of the cylinders, and equally ready access to the valves themselves.

In view of the foregoing, a detailed description of the operation of the device is deemed unnecessary and is therefore omitted in the interest of brevity.

Changes and variations may be made in the structure by means of which the invention is carried into effect. The invention, therefore, is not to be restricted to the precise details of the structure shown and described. Furthermore, certain parts of the invention are capable of use independent of other parts, and such independent use is contemplated.

What is claimed is:

1. The combination with a pair of cylinders each having a scavenging port adjacent its head, of a pair of rigidly connected valves controlling the ports, and connections between the valve mechanism and cylinders whereby pressure within one cylinder operates the valve mechanism to open the port of the other cylinder.

2. The combination with a pair of cylinders each having a scavenging port adjacent its head, of a casing, a pair of rigidly connected valves supported by the casing and controlling the ports, and connections between the casing and cylinders whereby pressure within one cylinder operates the valve mechanism to open the port of the other cylinder.

3. The combination with a pair of cylinders each having a scavenging port adjacent its head, of a casing spaced from the cylinders, a pair of rigidly connected valves supported by the casing and controlling the ports, and connections between the casing and cylinders whereby pressure within one cylinder operates the valve mechanism to open the port of the other cylinder.

4. The combination with a pair of cylinders each having a scavenging port adjacent its head, of a casing below the cylinders, a pair of rigidly connected valves supported by the casing and controlling the ports, and connections between the casing and cylin-

ders whereby pressure within one cylinder operates the valve mechanism to open the port of the other cylinder.

5. The combination with a pair of cylinders each having a scavenging port adjacent its head, of a casing, a pair of rigidly connected valves within the casing, and connections between the casing and cylinders whereby pressure within one cylinder operates the valve mechanism to open the port of the other cylinder.

6. The combination with a pair of cylinders each having a scavenging port adjacent its head, of a casing, a pair of rigidly connected valves within the casing and controlling the ports, and pipe connections between the casing and cylinders whereby pressure within one cylinder operates the valve mechanism to open the port of the other cylinder.

7. The combination with a pair of cylinders each having a scavenging port adjacent its head, of a pair of rigidly connected valves controlling the ports, connections between the valve mechanism and cylinders whereby pressure within one cylinder operates the valve mechanism to open the port of the other cylinder, and mechanism preventing intake of air through the ports.

8. The combination with a pair of cylinders each having a scavenging port adjacent its head, of a valve mechanism controlling the ports, connections between the valve mechanism and cylinders whereby pressure within one cylinder operates the valve mechanism to open the port of the other cylinder, and mechanism independent of the valve mechanism preventing intake of air through the ports.

9. The combination with a pair of cylinders each having a scavenging port adjacent its head, of a casing, valve mechanism supported by the casing and controlling the ports, connections between the casing and cylinders whereby pressure within one cylinder operates the valve mechanism to open the port of the other cylinder, and mechanism independent of and supported by the casing for preventing intake of air through the ports.

10. The combination with a pair of cylinders each having a scavenging port adjacent its head, of a casing, valve mechanism within the casing and controlling the ports, pipe connections between the casing and cylinders whereby pressure within one cylinder operates the valve mechanism to open the port of the other cylinder, and mechanism independent of the valve mechanism and carried within the casing for preventing intake of air through the ports.

11. The combination with a pair of tandem cylinders each having a scavenging port adjacent its head, of a casing the axis of which lies parallel with the axis of the cylinders, a pair of rigidly connected valves controlling the ports and supported by the casing, and connections between the casing and cylinders whereby pressure within one cylinder operates the valve mechanism to open the port of the other cylinder.

12. The combination with a pair of cylinders each having a scavenging port adjacent its head, of a pair of rigidly connected valves controlling the ports, and connections between the valves and cylinders whereby pressure within one cylinder operates the valve mechanism to open the port of the other cylinder.

13. The combination with a pair of cylinders each having a scavenging port adjacent its head, of a pair of rigidly connected valves controlling the ports, connections between the valves and cylinders whereby pressure within one cylinder operates the valve mechanism to open the port of the other cylinder, and mechanism preventing intake of air through the ports.

14. The combination with a pair of cylinders each having a scavenging port adjacent its head, of a pair of rigidly connected valves controlling the ports, connections between the valves and cylinders whereby pressure within one cylinder operates the valve mechanism to open the port of the other cylinder, and check valve mechanism preventing intake of air through the ports.

15. The combination with a pair of cylinders each having a scavenging port adjacent its head, of a pair of rigidly connected valves controlling the ports, connections between the valves and cylinders whereby pressure within one cylinder operates the valve mechanism to open the port of the other cylinder, and independently operating check valves preventing intake of air through the ports.

16. The combination with a pair of cylinders each having a scavenging port adjacent its head, of a casing having an outlet, a valve mechanism controlling the ports, connections between the casing and cylinders whereby pressure within one cylinder operates the valve mechanism to open the port of the other cylinder, and mechanism between the casing outlet and the ports preventing intake of air through the ports.

17. The combination with a pair of cylinders each having a scavenging port adjacent its head, of a casing having an outlet, a valve mechanism within the casing and controlling the ports, connections between the casing and cylinders whereby pressure within one cylinder operates the valve mechanism to open the port of the other cylinder, and a pair of check valves within the casing and between the outlet and ports for preventing intake of air through the ports.

18. The combination with a pair of cylinders each having a scavenging port adja-

cent its head, of a casing having an outlet, valve mechanism within the casing and controlling the ports, connections between the casing and cylinders whereby pressure within one cylinder operates the valve mechanism to open the port of the other cylinder, and a pair of check valves within the casing and between the outlet and valve mechanism for preventing intake of air through the ports.

19. The combination with a pair of cylinders each having a scavenging port adjacent its head, of a casing having an outlet, a pair of rigidly connected valves within the casing and controlling the ports, connections between the casing and cylinders whereby pressure within one cylinder operates the valves to open the port of the other cylinder, and a pair of independently operating check valves within the casing and between the outlet and ports for preventing intake of air through the ports.

20. The combination with a pair of cylinders each having a scavenging port adjacent its head, of a casing having an outlet and the axis of which lies parallel with the axes of the cylinders, a pair of rigidly connected valves within the casing and controlling the ports, connections between the casing and cylinders whereby pressure within one cylinder operates the valves to open the port of the other cylinder, and a pair of check valves within the casing and between the outlet and ports for preventing intake of air through the ports.

21. The combination with a pair of tandem cylinders each having a scavenging port adjacent its head, of a casing having an outlet and the axis of which lies parallel with the axis of the cylinders, a pair of rigidly connected valves slidable within the casing and on its axial line and controlling the ports, connections between the casing and cylinders whereby pressure within one cylinder operates the valves to open the port of the other cylinder, and a pair of check valves within the casing and between the outlet and ports for preventing intake of air through the ports.

22. The combination with a pair of tandem cylinders each having a scavenging port adjacent its head, of a casing having an outlet and the axis of which lies parallel with the axis of the cylinders, a pair of rigidly connected valves slidable within the casing and on its axial line and controlling the ports, pipe connections between the casing and cylinders whereby pressure within one cylinder operates the valves to open the port of the other cylinder, and a pair of check valves within the casing and working at right angle to the axis of the casing between the outlet and valves for preventing intake of air through the ports.

23. The combination with a pair of cylinders each having a scavenging port adjacent its head, of a casing provided with a pair of valve chambers and an outlet chamber common to both valve chambers, pipe connections between the casing and cylinders, valve mechanism within the casing and operated alternately in opposite directions by pressure within the cylinders and pipe connections to alternately open the ports of the cylinders to the valve chambers.

24. The combination with a pair of cylinders each having a scavenging port adjacent its head, of a casing provided with a pair of valve chambers and an outlet chamber common to both valve chambers, pipe connections between the casing and cylinders, valve mechanism within the casing and operated alternately in opposite directions by pressure within the cylinders and pipe connections to alternately open the cylinder ports to the valve chambers, and a pair of check valves alternately preventing intake of air through the ports.

25. The combination with a pair of cylinders each having a scavenging port adjacent its head, of a casing provided with a pair of valve chambers and an outlet chamber common to both valve chambers, pipe connections between the casing and cylinders, a pair of rigidly connected valves sliding within the casing and operated alternately in opposite directions by pressure within the cylinders and pipe connections to alternately open the cylinder ports to the valve chambers, and a pair of check valves alternately preventing intake of air through the ports.

In testimony whereof, I have signed my name to this specification in the presence of two subscribing witnesses.

HERBERT COOPER.

Witnesses:

FRANK H. VICK, JR.,

C. E. MARTIN.