B. V. NORDBERG.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED FEB. 24, 1914.

1,237,373.

Patented Aug. 21, 1917.

4 SHEETS—SHEET 1.

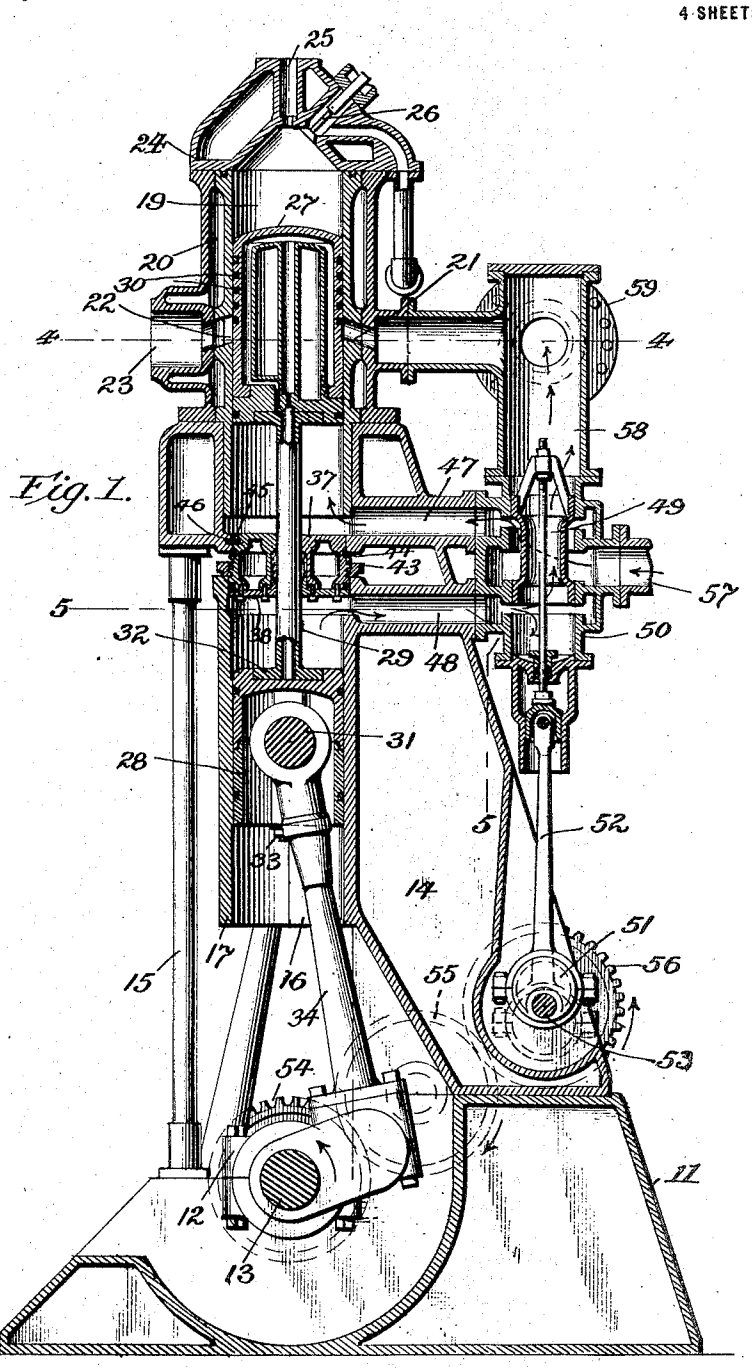

Fig. 1.

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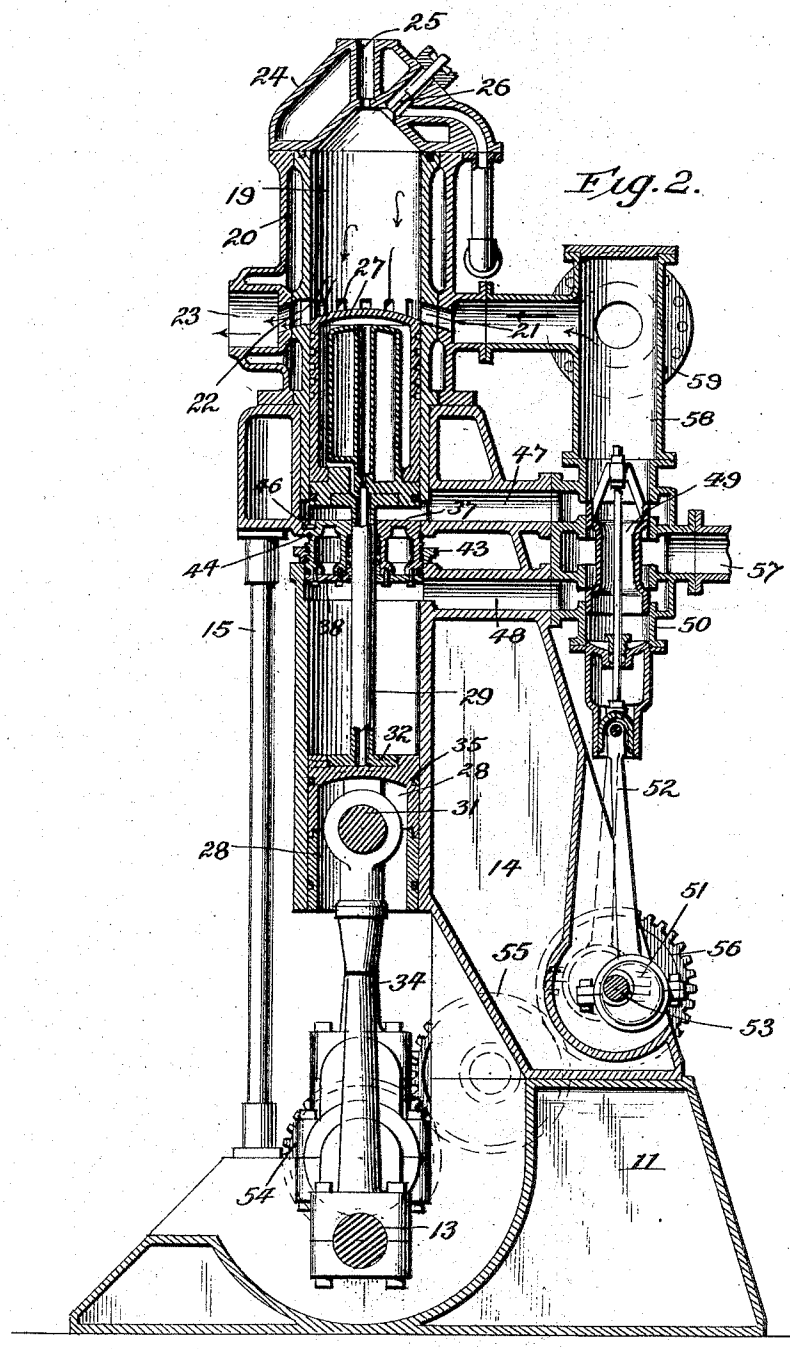
4 SHEETS—SHEET 2.

Fig. 2.



Witnesses

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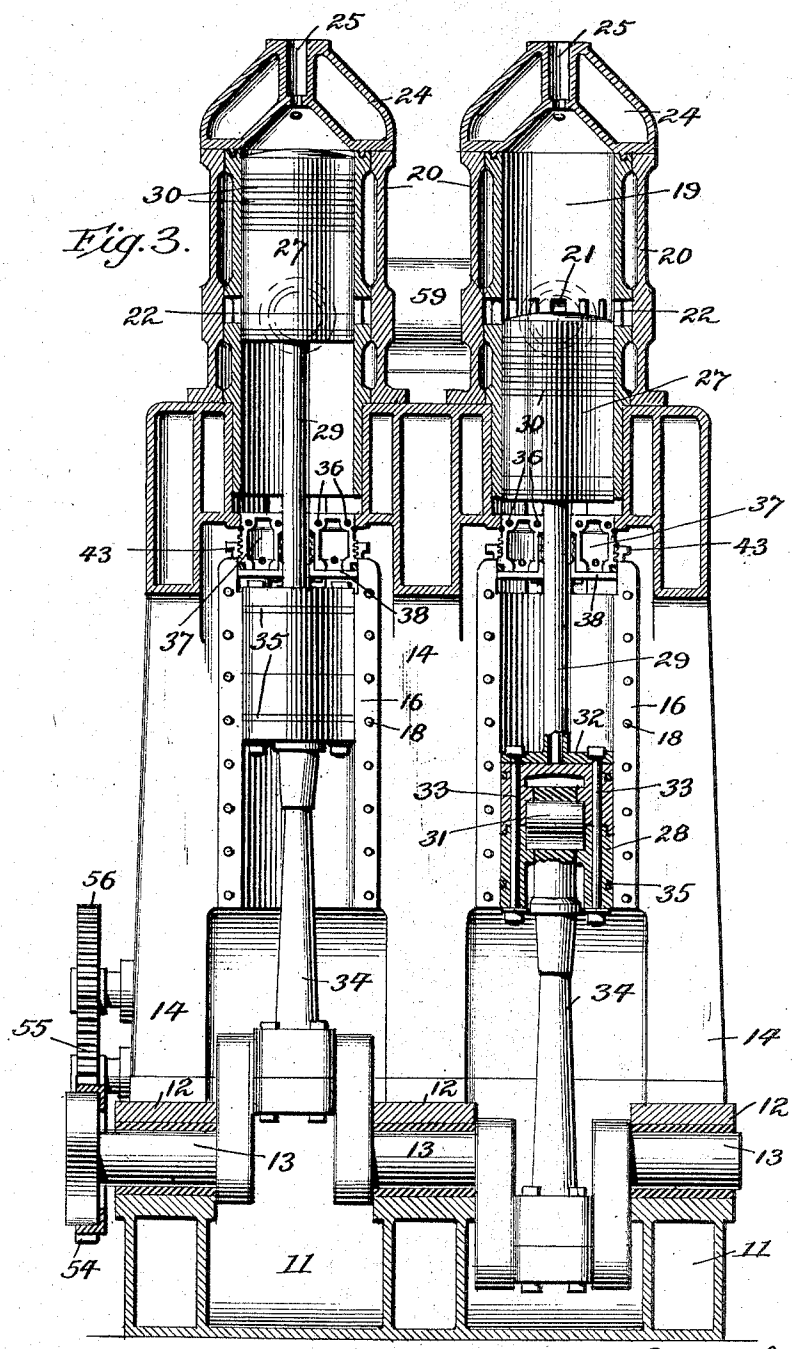
4 SHEETS—SHEET 3.

Fig. 3.



Witnesses

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4 SHEETS—SHEET 4.

Fig. 4.

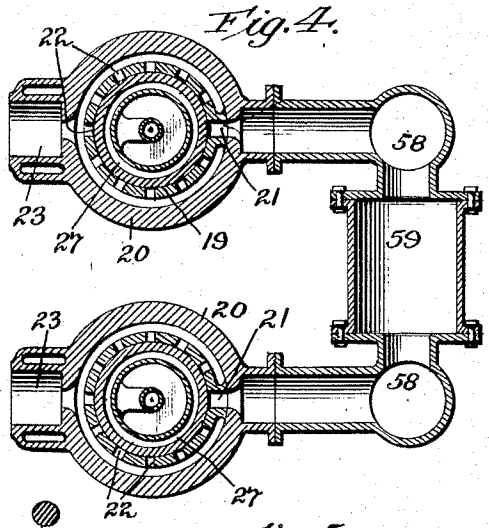

Fig. 6.

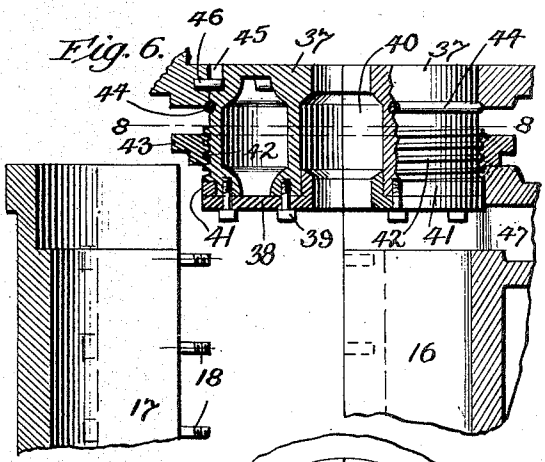

Fig. 7.

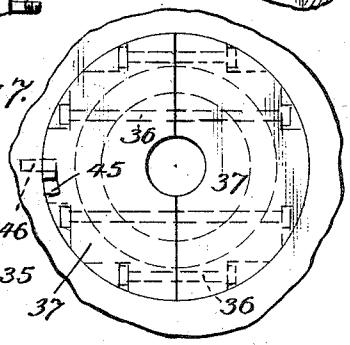

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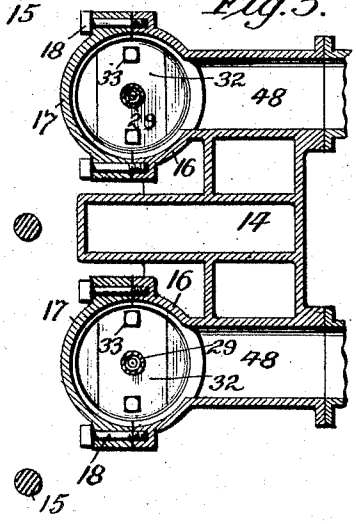
Fig. 5.



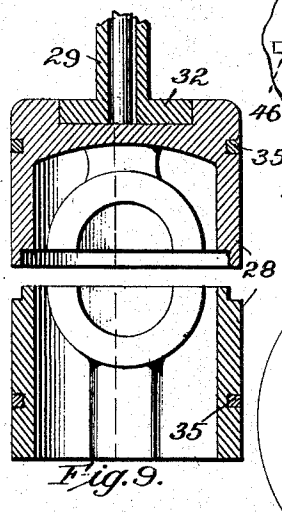


Fig. 9.

Fig. 8.

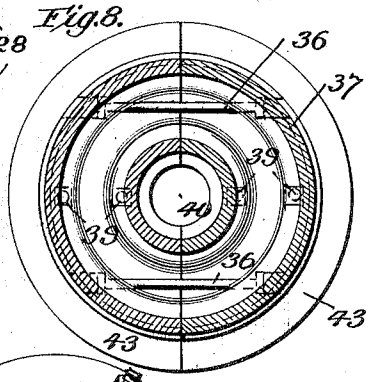


Fig. 10.

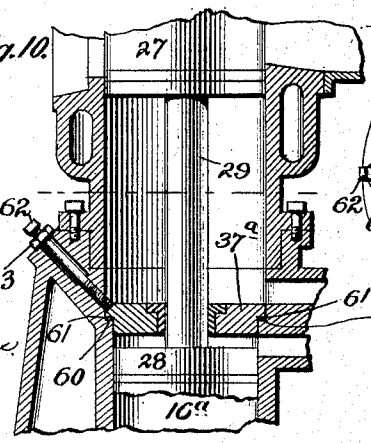
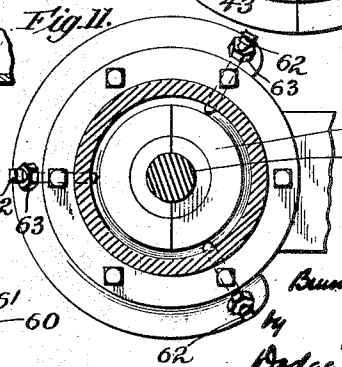


Fig. 11.



Witnesses

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UNITED STATES PATENT OFFICE.

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INTERNAL-COMBUSTION ENGINE.

1,237,373. Specification of Letters Patent. Patented Aug. 21, 1917.

Application filed February 24, 1914. Serial No. 820,558.

To all whom it may concern:

Be it known that I, BRUNO V. NORDBERG, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

This invention relates to internal combustion engines and particularly to slow combustion engines of the two cycle type. The object of the invention is the production of a simple air pump mechanism for providing air under pressure to scavenge the cylinder at the end of the working stroke. While attaining its greatest utility in the field specified the device is applicable to any single acting engine in which scavenging by compressed air is desirable.

Broadly stated the device comprises in addition to the usual parts of a single acting engine, a combined crosshead and supplemental piston, connected by a rod to the main piston; a combined cylinder and crosshead guide, a head closing the head end of the combined crosshead guide and cylinder and the crank end of the main cylinder; a distributing valve mechanism to cause these two cylinder spaces to serve as a double acting air compresser, and suitable means for admitting air compressed thereby to the head end space of the main cylinder at proper times for scavenging the same.

Practical embodiments of the invention are illustrated in the accompanying drawing, in which:—

Figure 1 is a vertical axial section through one of the cylinders, the plane of section being transverse to the shaft and the piston being shown in its compression stroke.

Fig. 2 is a view similar to Fig. 1 showing the piston at the crank end dead point and indicating the flow of air in the scavenging action.

Fig. 3 is a vertical axial section on a plane passing through the axis of the shaft the front half of the combined crosshead guide and cylinder being removed;

Fig. 4 is a section on the line 4—4 of Fig. 1;

Fig. 5 is a section on the line 5—5 of Fig. 1;

Fig. 6 is a fragmentary view showing the mode of assembling the intermediate cylinder head and crosshead guide, the front half of the guide being released and partially withdrawn;

Fig. 7 is a fragmentary view looking down on the cylinder head in Fig 6;

Fig. 8 is a section on the line 8—8 of Fig. 6;

Fig. 9 is an axial section of the combined crosshead and piston showing it separated to release the wrist pin; and

Figs. 10 and 11 are fragmentary views of a modified construction of the cylinder, crosshead guide and intermediate cylinder head.

A two cylinder engine is illustrated but it is to be understood that the invention is applicable to engines of any number of cylinders.

The engine is supported on a base casting 11 having crank shaft bearings 12 for the crank shaft 13. The main frame 14 is carried directly on the base casting 11 and is braced by stanchions 15. The main frame 14 carries the crosshead guides which are in the form of divided cylinders. These are made up of portions 16 formed directly on the frame 14 and removable portions 17 held thereto by bolts 18, the two parts fitting closely to make an air tight joint so that the guide may serve as an air compressor cylinder.

The working cylinders 19 are mounted on the top of frame 14 and are surrounded by water jackets 20. Each cylinder has a scavenging air port 21 and exhaust ports 22 leading to the exhaust connection 23 for the usual exhaust manifold (not shown). Each cylinder is provided with a jacketed head 24 having a fuel feed device 25 which is not illustrated in detail and which may be of any form adapted to this use. As the construction of this device is not a part of the present invention and as many such are known in the art, I have thought it sufficient to illustrate it diagrammatically. An air starting valve is indicated generally at 26, but this is not illustrated in detail for similar reasons.

The crosshead guide and the cylinder 19 are coaxial and the main piston 27 is connected to the combined crosshead and piston 28 by a hollow rod 29. The main piston 27 has the usual packing rings 30 and is cored out for the passage of cooling water which is supplied in the usual manner through the rod 29. The water connections to the rod 29

are omitted as not material to this invention, but they may be made by means of passages through the crosshead 28 and telescopic pipe connections thereto.

The crossheads 28 are each made in two parts, the plane of separation being on the axis of the wrist pin 31. The rods 29 each end in flange 32 and bolts 33 passing through the flange 32 and both portions of the corresponding crosshead provide for ready assembly. The connecting rods 34 are of the usual form as are the piston packing rings 35.

The frame 14 extends upward beyond the crosshead guide and overhangs the same, leaving a space for the insertion and removal of a divided head which closes the crank end of the main cylinder and the adjacent or head end of the combined crosshead guide and cylinder. This may take various forms but the application of the preferred form is illustrated in Figs. 1 to 9.

The head is made in two halves which are connected together by bolts 36. Each half comprises a main casting 37 and a follower plate 38. The bolts 36 hold the castings 37 together and the follower plates are held thereto by screws or studs 39. The castings 37 when bolted together form a cylinder head having a packing gland 40 for the rod 29 and a groove for a packing ring 41. The plates 38 are formed with projections to enter gland 40 and exert the necessary pressure on the packing. The plates 38 also retain ring 41 while permitting ready removal. The cylinder head is threaded at 42 to receive a ring or nut 43 also made in two parts bolted together. A groove is provided to receive a packing ring 44 of copper or other soft metal. A bayonet slot 45 is formed in the head to coact with a pin 46 at the lower end of the main cylinder.

In assembling the engine the piston 27 with its rod 29 are put in place. The portion 17 of the crosshead guide having been removed, the connecting rod 34, crosshead 28, wrist pin 31 and rod 29 are assembled and connected by the bolts 33. The two head castings 37 are then bolted together around rod 29 and the ring 44 is put in place, after which the head may be held up by engaging pin 46 in bayonet slot 45. The gland 40 is packed, ring 41 is placed in position and the plates 38 are fastened on. The nut ring 43 is bolted around the head after which the portion 17 of the guides is bolted in position. Finally the nut ring 43 is turned until a sealed joint is secured at the ring 44. The ring 41 secures the necessary tight joint at the head end of the lower or crosshead guide cylinder.

Air ports 47 and 48 lead from the cylinder spaces to reciprocating distributing valves 49, one for each cylinder unit in the engine, mounted in valve chests 50 which are bolted to the frame 14. The particular form of the distributing valve is not material and any other type of valve may be used if preferred. The valves are reciprocated by eccentrics 51 and rods 52. The eccentrics 51 are mounted on a lay shaft 53 driven at the same angular speed as the crank shaft 13 by the gears 54, 55, 56. The air enters chests 50 through the inlet ports 57 and is discharged through the connections 58 to a combined manifold and receiver 59 from which it flows to the scavenging ports 21 of the various cylinders. The air is admitted to scavenge the cylinders by the overtravel of the ports 21 by piston 27. This occurs at such a point that the scavenging port is open for about a quarter of a revolution permitting thorough scavenging. This, together with the relatively large volume of air handled secures thorough scavenging.

In one and two cylinder engines an enlarged receiver space is required but when more cylinders are used this may be reduced in volume. In a four cylinder engine the scavenging ports are open one after another in virtual continuity and no receiver space beyond the ordinary pipe manifold is required.

Figs. 10 and 11 show a modified construction of the cylinder head. The combined cylinder and crosshead guide 16^a is not divided and is of smaller bore than the main cylinder 19 giving a shoulder 60 against which is seated a head 37^a. This is made of two parts bolted together to facilitate removal from the rod 29. The head 37^a is held seated against shoulder 60 and packing 61 by a plurality of studs 62 arranged at regular intervals around the cylinder and having check nuts 63. The frame 14 is continuous up to cylinder casting 19, when this modified construction is used and the head 37 is drawn out through the head end of the main cylinder together with piston 27 and rod 29 after backing out studs 62 and releasing the connecting rod. In the modified construction parts substantially identical with those of the preferred construction bear the same reference numerals.

The engine shown is designed to run on the familiar two stroke cycle and on the Diesel or slow combustion principle. The cycle for each cylinder is as follows: The air above the piston 27 is compressed sufficiently by the upward movement of the piston to ignite the fuel when this is sprayed into it at or near the head end dead point. The expansion of the products of combustion forces the piston down until it overtravels ports 22 and they are exhausted. Shortly after the beginning of the exhaust the piston also overtravels port 21 admitting a blast of fresh air to the cylinder, to sweep out the spent gases and fill the cylinder with fresh air. This air is furnished by the cylinder

spaces below piston 27 and above the combined crosshead and piston acting as a double acting pump.

Having thus described my invention, what I claim is:—

1. In an internal combustion engine the combination of a double acting cylinder and a single acting cylinder arranged in tandem; a piston in the double acting cylinder; a combined piston-crosshead in the single acting cylinder; a rod connecting said piston and piston-crosshead; a crank shaft; crank connections between said shaft and piston-crosshead; means adapted to operate the head-end space of the double acting cylinder by internal combustion; a valve mechanism connected with the remaining two cylinder spaces to cause them to operate as air compressing pumps; and means adapted to admit air compressed thereby to the head-end space of the double acting cylinder only during exhaust therefrom to effect scavenging of said space.

2. In an internal combustion engine the combination of a double acting cylinder and a single acting cylinder arranged in tandem; a removable cylinder head closing the crank end of the double acting cylinder and the head-end of the single acting cylinder; a piston in the double acting cylinder; a combined piston-crosshead in the single acting cylinder; a rod connecting said piston and piston-crosshead; a crank shaft; crank connections between said shaft and piston-crosshead; means adapted to operate the head-end space of the double acting cylinder by internal combustion; a distributing valve driven from the crank shaft and connected with the remaining two cylinder spaces to operate them as air compressing pumps; and means for admitting air compressed thereby to the head-end space of the double acting cylinder only during exhaust therefrom to effect scavenging of said space.

3. In an internal combustion engine the combination of a double acting cylinder, having a scavenging air port and an exhaust port for the head-end space; a single acting cylinder arranged in tandem therewith; a removable cylinder head closing the crank end of the double acting cylinder and the head-end of the single acting cylinder; a piston in the double acting cylinder adapted to control the scavenging and exhaust ports thereof by overtraveling the same; a combined piston-crosshead in the single acting cylinder; a rod connecting said piston and piston-crosshead; a crank shaft; crank connections between said shaft and piston-crosshead; means adapted to operate the head-end space of the double acting cylinder by internal combustion; a distributing valve driven from the crank shaft and connected with the remaining two cylinder spaces to operate them as air compressing pumps; and connections adapted to conduct air compressed thereby to said scavenging air port.

4. In an internal combustion engine the combination of a double acting cylinder and a single acting cylinder arranged in tandem; a two part cylinder head adapted to be assembled around a piston rod; means adapted to clamp said head in position between the crank end of the double acting cylinder and the head end of the single acting cylinder; packing adapted to prevent leakage from either cylinder past said head; a piston in the double acting cylinder; a combined piston-crosshead in the single acting cylinder; a rod connecting said piston and piston-crosshead; a crank shaft; crank connections between said shaft and piston-crosshead; means adapted to operate the head-end space of the double acting cylinder by internal combustion; a distributing valve driven from the crank shaft and connected with the remaining two cylinder spaces to operate them as air compressing pumps; and means for admitting air compressed thereby to the head-end space of the double acting cylinder during exhaust therefrom to effect scavenging of said space.

5. In an internal combustion engine, the combination of a double acting cylinder; a single acting cylinder formed in two longitudinally separable parts, spaced from the double acting cylinder and in tandem therewith; a sectional cylinder head clamped between the two parts of said single acting cylinder; a threaded locking device adapted to urge said head into sealing relation with the adjacent crank end of the double acting cylinder; suitable packing for the joints between said head and cylinders; a piston in the double acting cylinder; a combined piston-crosshead in the single acting cylinder; a rod passing through said sectional cylinder head and connecting said piston and piston crosshead; a crank shaft; crank connections between said shaft and piston-crosshead; means adapted to operate the head-end space of the double acting cylinder by internal combustion; a valve mechanism connected with the remaining two cylinder spaces to cause them to operate as air compressing pumps; and means adapted to admit air compressed thereby to the head-end space of the double acting cylinder during exhaust therefrom to effect scavenging of said space.

6. In an internal combustion engine the combination of a supporting frame; a multiple-throw crank shaft; an air manifold; and a plurality of power units mounted on said frame and each comprising the following elements, a double acting cylinder and a single acting cylinder arranged in tandem, a piston in the double acting cylinder, a combined piston-crosshead in the single acting cylinder, a rod connecting said piston

and piston-crosshead, crank connections between said crank shaft and piston-crosshead, mechanism adapted to operate the head-end space of the double acting cylinder by internal combustion, a distributing valve driven from said crank shaft and connected with the remaining two cylinder spaces to operate them as air compressing pumps, discharge connections from said valve to said air manifold and connections between said manifold and the head-end space of the double acting cylinder adapted to conduct air to said space for scavenging purposes only during exhaust from said space.

7. In a twocycle engine, a pair of cylinders, a partition member and a pair of connected pistons in each cylinder dividing the cylinder into two compression chambers and a firing chamber, a crank shaft to which said pistons are connected, means for admitting fresh air to the compression chambers, and means for conveying the air compressed in two compression chambers in unison to one firing chamber.

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

BRUNO V. NORDBERG.

Witnesses:
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H. W. DOW.