J. COCHAUD.

AIR COMPRESSOR SYSTEM FOR OIL ENGINES.

APPLICATION FILED AUG. 5, 1911.

1,102,321.

Patented July 7, 1914.

2 SHEETS—SHEET 1.

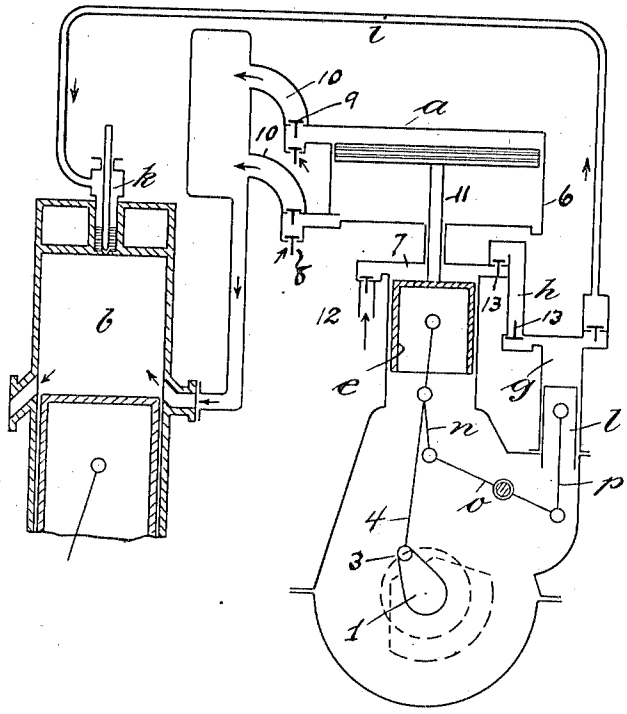


Fig: 1.

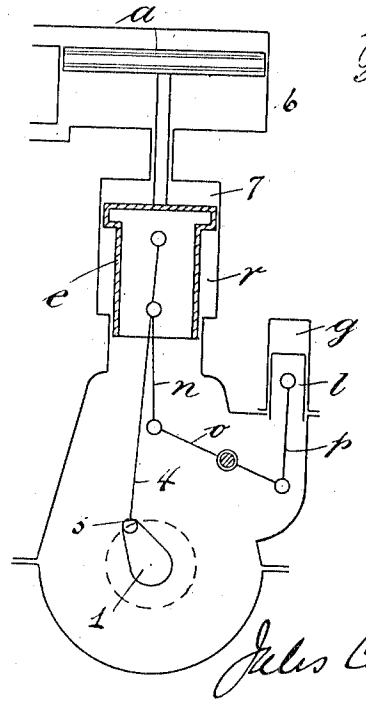


Fig: 2.

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Max B. A Doring
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By Attorney

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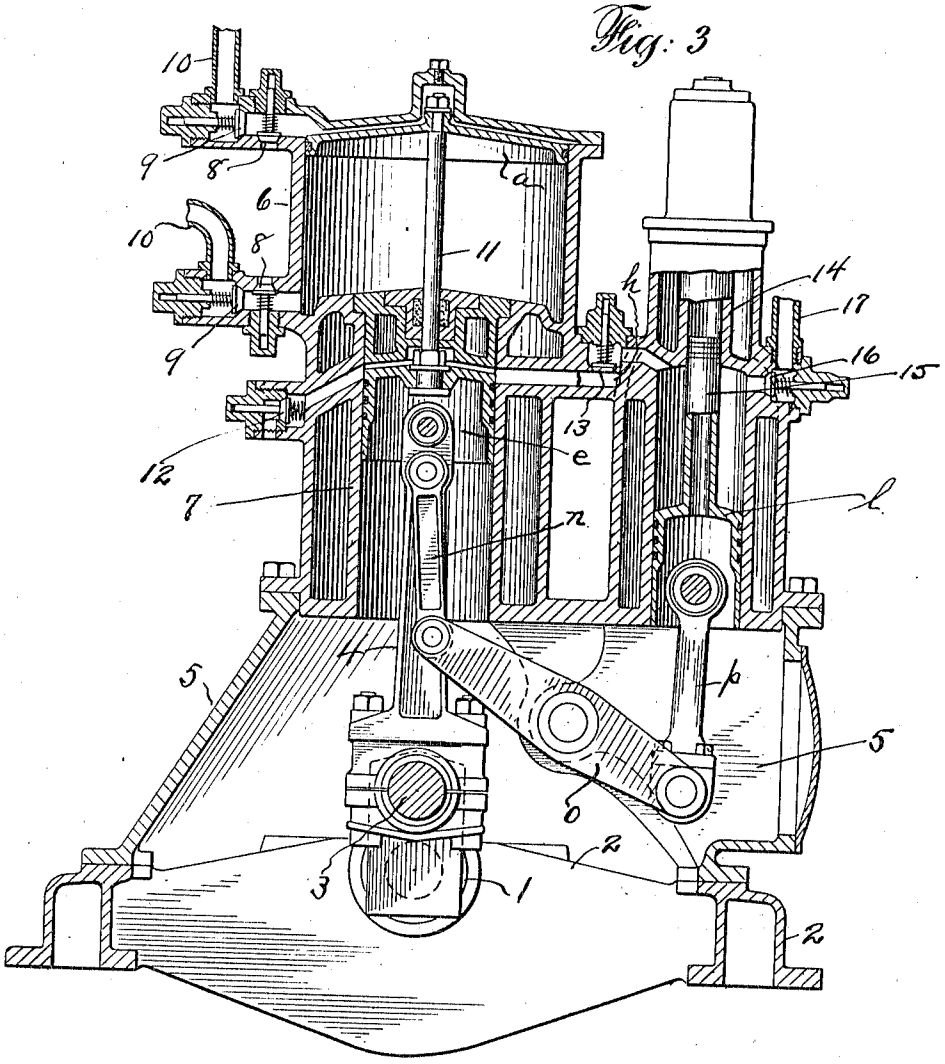
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2 SHEETS—SHEET 2.

Fig. 3



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UNITED STATES PATENT OFFICE.

JULES COCHAUD, OF ZURICH, SWITZERLAND, ASSIGNOR TO BUSCH-SULZER BROS.-DIESEL ENGINE COMPANY, OF ST. LOUIS, MISSOURI, A CORPORATION OF MISSOURI.

AIR-COMPRESSOR SYSTEM FOR OIL-ENGINES.

1,102,321. Specification of Letters Patent. Patented July 7, 1914.

Application filed August 5, 1911. Serial No. 642,435.

To all whom it may concern:

Be it known that I, JULES COCHAUD, a citizen of Switzerland, residing at 19 Klausstrasse, Zurich, Switzerland, have invented the Improvements in Air-Compressor Systems for Oil-Engines set forth in the following specification.

The invention is an improvement in 2-cycle oil engines of the type wherein air is compressed by mechanism directly coupled to the engine crank-shaft for the purpose of atomizing and injecting the fuel as well as for scavenging the cylinder or for other purposes, the fuel injection air being compressed in two or more stages; and the invention consists in the construction and arrangement of the several compressor cylinders and the other parts, and in the proportion of the same and their relation to the engine crank-shaft whereby the said engine and compressor mechanism are adapted to run at high speeds without injurious vibration and whereby there also results an equalization of the crank effort in the driving of the compressor mechanism.

The invention also provides a disposition of the compressor cylinders which occupies the least space and readily conforms in its general dimensions to the size and shape of the combustion cylinders of the engine proper, thereby enabling a series of four or more of such cylinders to be supplied with all the compressed air necessary for their operation by means of mechanism not substantially differing in size or general appearance from the cylinders themselves.

In the drawings forming part hereof the invention is illustrated in diagram in Figure 1, which shows the relation of the compressor cylinders and their connections to the combustion cylinder. Fig. 2 shows a modified form also in diagram and Fig. 3 shows a vertical section, through the axis of the scavenging cylinder, of an actual construction wherein the injection air for the fuel is compressed in three stages.

The engine crank-shaft is marked 1, being journaled on the bed plate 2 and is provided with a crank 3 and pitman 4 by which the several compressor plungers are operated. A crank case 5 surrounds the crank and may form the support for the compressor cylinders of which there are several, corresponding to the number of degrees of compression required for the production of the necessary compressed air. In the preferred embodiment of the invention the cylinder 6 of lowest pressure and largest volume is unjacketed and mounted directly upon the top of the cylinder 7 which is of smaller volume and water-jacketed. The two cylinders are in axial alinement, and, with the waterjacket, the cylinder 7 is substantially of the same diameter as the cylinder 6, as shown in Fig. 3. It will be understood that directly behind these two superposed cylinders is arranged the series of upright combustion cylinders, all perpendicular to the crank-shaft 4 with their several pistons connected to the latter whereby the same is rotated in the usual manner. These parts are of ordinary construction and hence omitted from the drawings being concealed by the cylinders 6 and 7 and the water jacket of the latter. The larger cylinder, 6, is intended to produce the air of lowest pressure, which is used for scavenging the combustion cylinders, and this cylinder 6 is provided with suction valves 8, at its opposite ends, leading from the atmosphere and corresponding discharge valves 9 with pipes 10 which lead to any suitable container in proper communication with the scavenging ports of the engine cylinder. The plunger *a* of the scavenging air cylinder is double-acting and mounted on a plunger rod 11 which passes through a gland in the lower head of the cylinder 6, into the cylinder 7 where it is connected to the plunger *e* of that cylinder and the plunger *e* is directly connected to the pitman 4 above referred to, whereby both plungers are simultaneously and equally reciprocated by the engine crank-shaft, the lower serving as a cross-head for the former. The lower cylinder 7 is provided at its upper end with a suction valve 12 leading from the atmosphere, or if desired, from the container above referred to, and also with a discharge valve 13 which communicates with a pipe *h*. Its plunger *e*

is single-acting, in the form of the invention shown in Fig. 3 and shown diagrammatically in Fig. 1, so that on the upstroke of the pitman 4 the two plungers are both acting to compress air, while on the down stroke only one of them is so acting.

The pipe or conduit *h* leads to the water-jacketed cylinder *g* used for the second stage of the compression of injection air, which cylinder is mounted adjacent to and preferably parallel with the two cylinders above referred to, and supports the water jacketed cylinder 14, the latter being preferably formed as an upward continuation of the cylinder *g* but of smaller diameter and representing the final or third stage of compression of the fuel injection air. The plungers *l* and 15 for the 2nd and 3rd stage cylinders are or may be formed in one piece of two diameters corresponding to their respective cylinders and are both single-acting and connected to be driven by the engine crank-shaft in opposition to the low pressure pistons *a* and *e* above referred to. The connections for this purpose may consist of an equal-arm rocking lever *o* connected to the plunger *l* by means of the link *p* and to the pitman 4 by means of another link *n*, so that the upward stroke of the low pressure plungers *a* and *e* is substantially equal to the down stroke of the plungers *l* and 15 and vice versa. The air duct *h* leads to the upper end of the second stage cylinder and the air is forced therefrom through discharge valve 16 and the pipe 17 to the upper end of cylinder 14 of the other stage, being thence conducted through any suitable valve mechanism and piping to the fuel valve of the engine. The diagram of Fig. 1 represents exactly the same arrangement of compressor cylinders, except that the injection air is compressed to the desired pressure by two instead of three stages; the plunger *l* being a single plunger of uniform diameter arranged to compress the air received from the pipe *h* directly into the pipe *i* which leads to the fuel valve. The latter is marked *k* in this figure and its combustion cylinder is marked *b*, it being understood that there are several of these cylinders each supplied with similar fuel valves, although only one appears in the diagram, and also that the pistons of these cylinders all act on the crank-shaft 4.

In oil engines of the type referred to the momentum of the relatively large and therefore heavy piston *a* of the double-acting scavenging compressor becomes extremely great when the engine is run at the high speeds required for instance in marine propulsion, the effect of this momentum being increased by the fact that the scavenging compressor works with very low pressure, that is to say by the fact that the increase of the pressure toward the ends of the pumping strokes exerts little or no reducing influence upon the effects of the masses. The vibration thus produced works severe injury to the entire power plant, practically prohibiting its operation at the desired speed and compelling the use of divided or multiple scavenging air compressors counter balanced in units or groups each against the other, or else the use of massive counter-weights on the crank-shaft as the only available means by which such desired speeds can be obtained. In the arrangement above described the compressor cylinders are so arranged that one or several of the stages of the compression of the injection air is brought into use to reduce the effect of the rapidly moving mass of the scavenging air plunger, at each of its strokes. Thus in Fig. 3 the upstroke of the piston *a* is made against the compression of the lowest or first stage of the compression of injection air compressed by plunger *e* and the downstroke is made against the compression of the two other stages of compression of the injection air as will be readily understood. Moreover the relative areas of the plungers acting on the up and down strokes are so proportioned that the retarding influence to which the scavenging plunger is subjected on its upstroke is substantially equal to that to which it is subjected on its downstroke and the crank efforts of the crank 3 are thus substantially equalized so that the load on the engine crank-shaft is thus preserved uniform resulting in conditions best adapted for high speeds. The division of the injection air plungers and cylinders into groups, with the rocking lever connection 4 driving the group 1, results in relieving the crank pin 3 of a portion of the tangential inertia efforts. In the diagrammatic representation of Fig. 1 which produces only two stage compression of the injection air, the conditions are the same, since the area of the final (second) stage compression plunger *l* in conjunction with the relatively higher pressure of the air with which it deals is substantially equal in its retarding effect to the load on the first stage plunger 7, so that the momentum of the lower pressure and double-acting scavenging-air plunger is correspondingly and equally balanced without shock or vibration.

In the modified form of Fig. 2 the conditions and connections are the same as already described except that here the plunger *e* is double-acting, being formed as a so-called differential piston. In its upstroke it opposes the momentum of the scavenging plunger *a* by the compression of air by its upper and relatively large face and in its down stroke by the compression of air by its annular lower face working in

the space *r* and supplemented by the retarding force of the auxiliary plunger *l*. The lower annular plunger face working in the space *r* may represent the second stage of the compression of the injection air and the auxiliary cylinder *g* and plunger *l* the third or final compression, but in any case the work to be done by the upwardly and downwardly working plungers will be substantially equal to preserve the desired balance permitting high speeds. In both instances the low pressure stage of the injection air pump is disposed in coaxial alinement with the double-acting scavenging pump and between the same and the crank which drives the whole compressor mechanism. This relative disposition of the parts is of special advantage in the successful operation of the system.

In the foregoing exemplifications of the invention the upstroke and downstroke cylinders and plungers are arranged in the same plane transverse to the engine crank-shaft and preferably at one end of the latter, and the cylinders of the fuel injection air are all water-jacketed whereas the scavenging air cylinder is not water-cooled. The air which is supplied from the latter cylinder scavenges the combustion cylinders and also serves as the air charge which is or may be compressed therein to the desired ignition temperature of the fuel as in the case of engine of the Diesel type.

Having described my invention, I claim the following:

1. In a 2-cycle oil-engine the combination with the engine crank-shaft of air compressor mechanism driven thereby and comprising a double-acting low pressure and relatively large volume cylinder with a plunger therein, a series of two or more cylinders with plungers adapted to compress air in several stages to a higher pressure and mechanism for connecting said latter plungers with the low pressure double-acting plunger to counteract and balance the effects of the momentum of the said low pressure plunger, one of said plungers being connected in coaxial alinement with the low pressure plunger, between the same and the crank driving the compressor mechanism.

2. In a 2-cycle oil-engine the combination of the engine crank shaft having a crank thereon, a pitman connected to said crank, a large volume, low pressure plunger driven by the pitman and a cylinder therefor, a series of plungers and cylinders acting to compress air in successive stages to a relatively higher pressure, said latter plungers being divided in groups and the said groups being respectively connected to the pitman to work on the up and down strokes thereof, whereby the work done by the latter plungers counteracts the momentum of the low pressure plunger in both directions of its movement, one of said groups being connected in coaxial alinement with said low pressure plunger, between the same and said pitman.

3. In a 2-cycle oil-engine, the combination with the engine crank shaft having a crank for driving air compressor mechanism, of said air compressor mechanism connected with said crank and comprising a double-acting scavenging air cylinder and a plunger therein, a plurality of cylinders arranged to compress the fuel injection air in two or more stages, and plungers in the latter cylinders connected with the plunger of the scavenging cylinder to work on the opposite strokes of the same to counteract the momentum thereof in its opposite strokes.

4. In a 2-cycle oil-engine, air compressor mechanism comprising two or more cylinders with plungers adapted for compressing air for fuel injection in a corresponding number of stages, and a scavenging air cylinder and plunger mounted coaxially with and upon one of said cylinders and its plunger, in combination with the engine crank-shaft and connections therewith for operating the said plungers, the organization of the said connections being such that the fuel injection plungers coöperate with the scavenging plunger to counteract the momentum of the latter in both its directions of movement.

5. In a 2-cycle oil-engine, air compressing mechanism comprising two or more cylinders with plungers adapted for compressing fuel injection air in a corresponding number of stages, and a scavenging cylinder mounted upon the lowest stage injection air cylinder with its plunger coaxially connected with the plunger of the latter, in combination with the engine crank-shaft, a pitman connecting the same with the aforesaid connected plungers and a rocking-lever connecting said plungers with the other plunger or plungers to cause the same to work in alternation thereto.

6. In a 2-cycle oil-engine having a plurality of parallel combustion cylinders and a crank-shaft, a pitman connected to the latter and air compressor mechanism driven by the pitman, said mechanism comprising a series of plungers and cylinders adapted to compress air in several stages to a high pressure and a double-acting low pressure plunger having its cylinder mounted in coaxial alinement with one of the aforesaid cylinders and its plunger connected to the plunger thereof and to the said pitman, in combination with connections for driving the remaining plunger or plungers in the opposite direction.

7. In a 2-cycle oil-engine, a double-acting scavenging air pump, an injection air pump

connected with the same crank which drives the scavenging air pump, said injection air pump comprising two or more stages of which the low pressure stage is connected coaxially with the scavenging air pump between the same and said crank, the remaining stage or stages of the injection air pump being located at one side and being provided with connections whereby they are driven by the crank in opposite directions to the scavenging air pump and said low pressure stage of the injection air pump.

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

J. COCHAUD.

Witnesses:
CARL GUBLER,
AUGUST RÜEGG.