

1,287,325.

Patented Dec. 10, 1918.

Fig. 1.

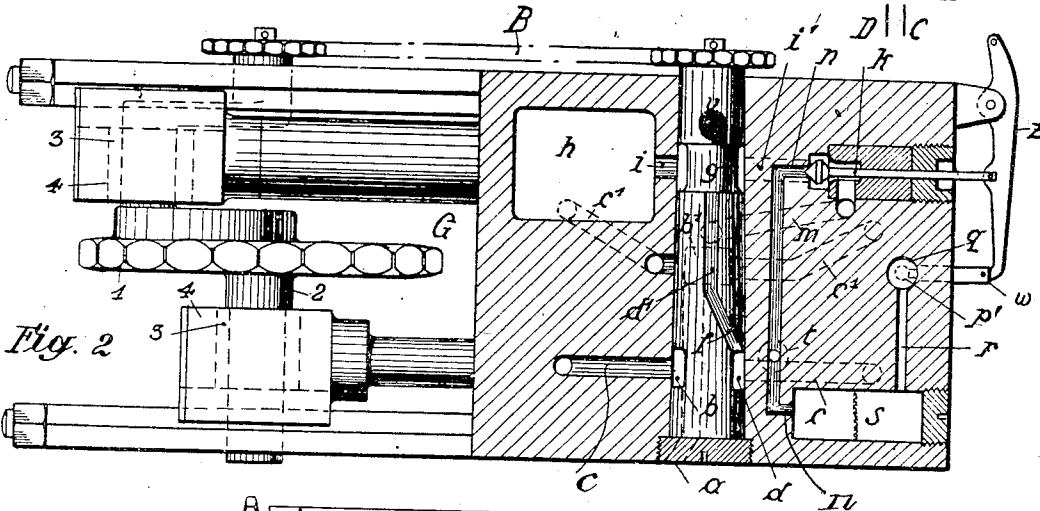
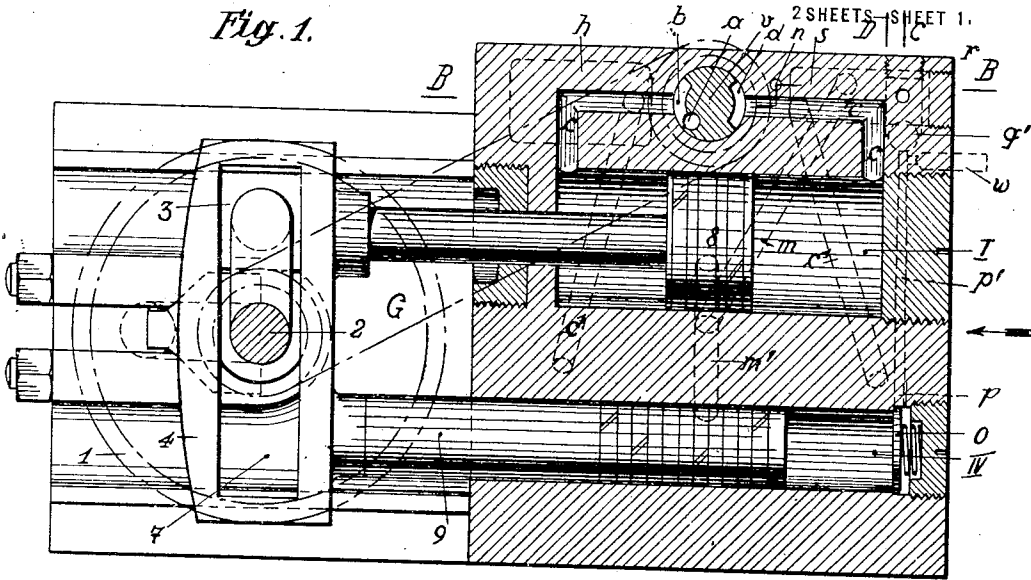


Fig. 2.

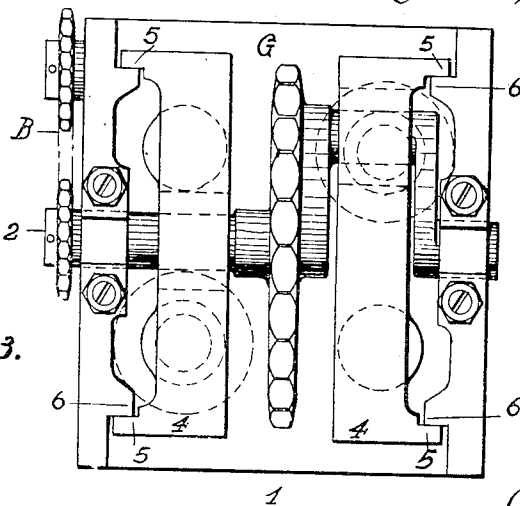


Fig. 3.

Inventors:
Anton Huwiler,
Harry Maggi,
By *Henry Maggi*
Atty.

A. HUWILER & H. MAGGI.
PNEUMATIC STARTER FOR ENGINES.
APPLICATION FILED OCT. 12, 1916.

1,287,325.

Patented Dec. 10, 1918.

2 SHEETS—SHEET 2.

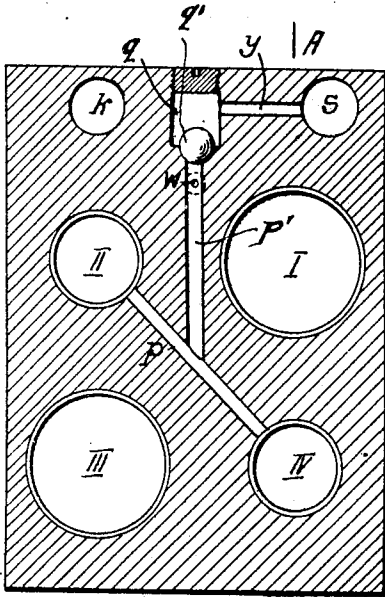


Fig. 4. | A

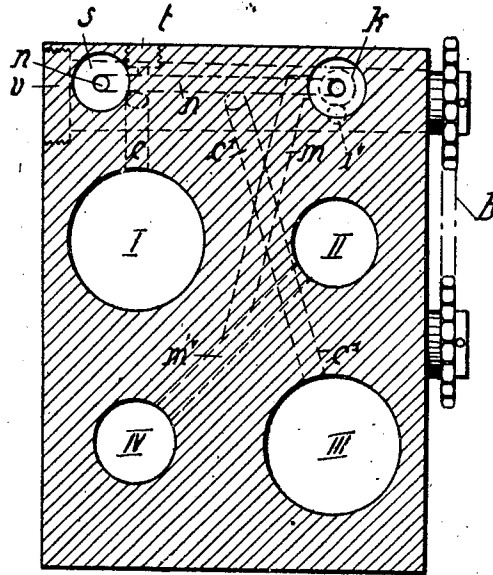


Fig. 5.

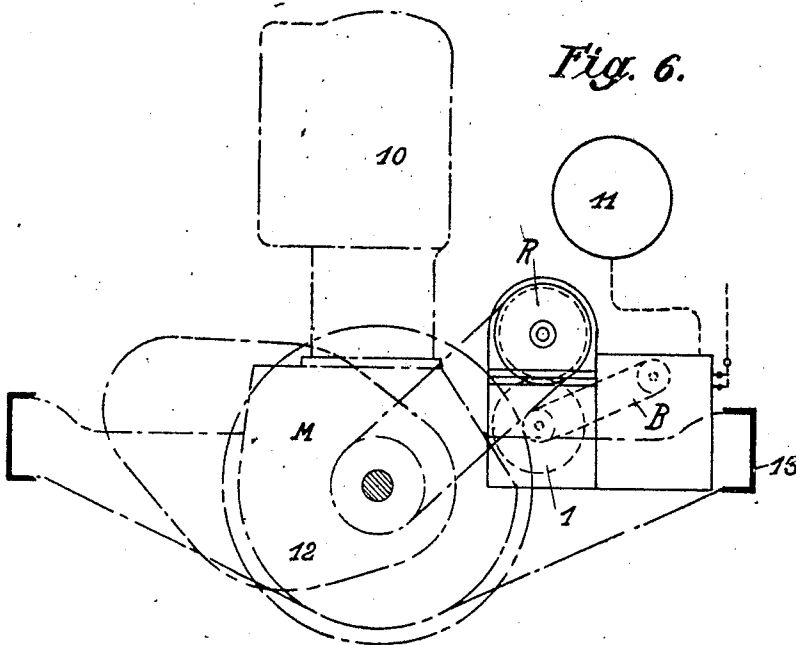


Fig. 6.

Inventors:
Anton Huwiler
Harry Maggi
By Harry Maggi atty.

UNITED STATES PATENT OFFICE.

ANTON HUWILER, OF BASEL, AND HARRY MAGGI, OF ZURICH, SWITZERLAND.

PNEUMATIC STARTER FOR ENGINES.

1,287,325.

Specification of Letters Patent.

Patented Dec. 10, 1918.

Application filed October 12, 1916. Serial No. 125,210.

To all whom it may concern:

Be it known that we, ANTON HUWILER, of Basel, and HARRY MAGGI, of Zurich, Switzerland, both citizens of Switzerland, have invented certain new and useful Improvements in Pneumatic Starters for Engines; and we do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters or figures of reference marked thereon, which form a part of this specification.

The object of the present invention is to provide a starter which by reason of its compact construction is especially suitable for motor cars of various makes. To allow of holding a large amount of compressed air in a small storage chamber the apparatus compresses the air very highly, to about 100 atmospheres, and with such a large storage of energy motors of very high power can be started. Moreover, the apparatus gives very reliable action. The invention is illustrated in the annexed drawings, showing one form of construction.

Figure 1 is a longitudinal section of the apparatus on the line A A of Fig. 4.

Fig. 2 a plan view, partly in section on the line B B of Fig. 1.

Fig. 3 is an end view of the apparatus seen from the crank shaft.

Fig. 4 is a cross section on the line C C of Fig. 1.

Fig. 5 is a cross section on the line D D of Fig. 1.

Fig. 6 is a diagram illustrating the application of the apparatus to a motor car driven by an internal combustion engine.

In Figs. 1, 4 and 5, I and III are low pressure cylinders and II and IV the high pressure cylinders formed in the casing G; 8 is the piston in the cylinder I and 9 the piston in the cylinder IV. 4 are cross-heads, with each of which the pistons of one high pressure cylinder and one low pressure cylinder are connected. 3 are slide bearings for the crank-shaft 2 the bearings sliding in slide 7 in the cross-heads 4; 6 are guides for the cross-heads. 1 is the driving sprocket wheel for the crankshaft 2, B the driving chain for the distributing valve *v*, R is a reducing gear, and M the explosion motor; *o* are valves for the discharge of compressed air from the high pressure cylinders, *q* is a non-

return valve, *s* an air filter chamber, *t* the connection of the casing G to the steel flask 11, shown in Fig. 6 for the compressed air, *z* the lever for the control valve *k*, and *w* is a relief valve controlled by the lever *z*.

The distributing valve *v* is cylindrical and is rotatably mounted in a bore of the casing G transversely to the cylinders. A longitudinal passage *a* in the valve communicates at one end with the atmosphere and with arcuate passages *b*, *b'*, formed in the periphery of the valve at different longitudinal positions and angularly displaced in relation to each other, as shown in Fig. 2.

In the casing G are formed two channels *c*, *c*, which communicate with the bore on opposite sides of the valve *v* and with opposite ends of the low pressure cylinder I (Fig. 1) while channels *c'*, *c'* in the casing also connect opposite sides of the bore with opposite ends of the low pressure cylinder III as shown in dotted lines, Figs. 1 and 5.

The passage *b*, during the rotation of the valve *v* communicates alternately with the channels *c*, *c*, while the passage *b'* communicates alternately with the channels *c'*, *c'*.

Formed in the periphery of the valve *v* opposite the passage *b* is an arcuate passage *d* and extending longitudinally of the valve in the periphery thereof on the side opposite the passage *b'*, is formed a passage *d'*. The passage *d* during the rotation of the valve *v* communicates alternately with the channels *c*, *c*, while the passage *d'* communicates alternately with the channels *c'*, *c'*. The passages *d*, *d'*, communicate through a diagonal passage *f* formed in the valve and the passage *d'* extends into an annular passage *g* formed in the valve beyond the end of passage *a*. This annular passage *g* communicates on one side of the bore, through a channel *i*, with a chamber *h*.

The chamber *h* is adapted to communicate with the high pressure cylinders II and IV by means of a channel *j'* which communicates with said chamber *h* and is adapted to communicate with a channel *m* controlled by a valve *k* (Fig. 2) and this channel *m* communicates with a channel *m'*, the latter being directly connected at opposite ends to the high pressure cylinders between the ends thereof, (Figs. 1 and 4).

A channel *p* is arranged to communicate at opposite ends with one end of each high pressure cylinder and a spring controlled valve *o* is mounted in each of the latter to

prevent back pressure from the channel *p* to the high pressure cylinders. This channel *p* communicates with a channel *p'*, the upper end of which opens into a valve chamber *q* and this chamber *q* contains a non-return valve *q'* adapted to close the upper end of the channel *p'* and said chamber *q* communicates, by means of a channel *r*, with a filter chamber *s*. The filter chamber *s* communicates with one end of a channel *n* the other end of which is closed, under certain conditions hereinafter described, by the valve *k*. The channel *n* is provided at a point between its ends with a port *t* through which said channel communicates with a storage chamber or flask 11. The valved end of this channel *n* communicates, when opened by the valve *k*, with the channel *i'* which, as stated above, communicates with the chamber *h*.

An exhaust valve *w* is provided in the channel *p* below the non-return valve *q'*.

The working of the apparatus is as follows:

When the crank-shaft 2 is driven by means of the sprocket wheel 1 the cross-heads 4 are reciprocated, by reason of their connection with the crank-shaft, and the pistons are also reciprocated. If the starting apparatus is working as a compressor, air passes (during suction stroke) at *a* (Figs. 1 and 2) into the distributing valve *v* and through the passage *b b'* and channels *c, c* and *c', c'* alternately, into the large cylinders I and III. The valve *v* is driven from the crank-shaft by the chain B, and consequently always rotates in the same direction as the crank-shaft. During the compression stroke the air flows from the large cylinders I and III alternately through the channels *c, c* and *c', c'* in the casing G, the passage *d, d', f* and *g* of the valve, and channel *i* to the chamber *h*.

From the chamber *h* the air flows into the high pressure cylinders II and IV through the channel *i*, past valve *k* and through channels *m, m'*. The valve *k* being positively actuated (through the lever *z*) closes the channel *n*. The air compressed in the high pressure cylinders flows past the valves *o*, through channels *p, p'*, past non-return valve *q'*, Fig. 4, and channel *r* to the filter chamber *s*, and thence through the channel *n* and port *t* to the storage chamber or flask 11, (Fig. 6).

When the apparatus is to work as a motor the valve *k* is set by means of its lever so that the channel *n* is opened and the channel *m* closed. The direction of rotation of the crank-shaft is now reversed by any suitable mechanism (not shown) and only the low pressure cylinders are operative. Compressed air is then admitted from the storage chamber or flask 11 to the casing G, and flows through the port *t*, channel *n*, past

valve *k* and through channel *i'* to the chamber *h*. The flow of air through the filter chamber *s* is now prevented by the valve *q'*. From the chamber *h* the air flows through the channel *i* to the distributing valve *v* and through passages *g, a', f* and *d*, to the channels *c, c* and *c', c'* leading to the cylinders I and III. The exhaust from the low pressure cylinders takes place through passage *a*. The exhaust valve *w* connected also to lever *z* allows the air to escape into the atmosphere from the cylinders II and IV, so that the pistons in these cylinders do not oppose the working of the apparatus as a motor.

The high pressure cylinders II and IV are single acting, and when the apparatus is working as a motor their pistons move idly. These pistons have no stuffing boxes at the crank-shaft end.

For obtaining good efficiency when working as a compressor, the number of revolutions is kept at about 350 to 400 per minute. For this purpose the reducing gear R (Fig. 6) is provided, giving the number of revolutions required during the compression work, whereas when the apparatus is used for starting, a high number of revolutions is obtained owing to the direct admission of the compressed air at high pressure to the cylinders I, III. In Fig. 6, 12 is the motor casing, 10 the motor cylinder, 13 the car frame, and 11 the air flask. In the case of motors where it is possible the reducing gear is placed directly on the motor shaft, and need not be mounted as illustrated, above part of the apparatus.

What we claim as our invention and desire to secure by Letters Patent of the United States is:

1. A pneumatic starter for engines comprising a crank shaft, two pairs of cylinders, each pair consisting of a double acting low pressure motor cylinder and a single acting high pressure compressor cylinder, one pair arranged above the plane of the crank shaft and the other pair arranged below said plane, pistons in the cylinders, and cross-heads connecting the pistons to the crank shaft.

2. A pneumatic starter for engines as claimed in claim 1, in which the crank shaft and cross-heads are arranged in a casing common to both pairs of cylinders.

3. A pneumatic starter for engines as claimed in claim 1, in which, means are provided for compressing the air in two stages whereby the compression is double acting in the low pressure stage and single acting in the high pressure stage, only the low pressure cylinder being operative when the apparatus is used as a motor.

4. A pneumatic starter for engines as claimed in claim 1, in which a positively controlled rotary distributing valve is pro-

vided and passages controlled by the valve for alternately supplying air to the double acting low pressure cylinders.

5 5. A pneumatic starter for engines as claimed in claims 1 and 2, in which the casing is formed with a plurality of passages for supplying air to the cylinders, a pressure reservoir connected with the passages, and a positively actuated rotary distributing valve for controlling said passages whereby
10 air is supplied alternately to the low pressure cylinders and exhausted from the latter to the atmosphere through the valve.

15 6. A pneumatic starter for engines as claimed in claims 1 and 2, operating as a compressor in which the casing is formed with a plurality of passages for supplying air to the cylinders, a pressure chamber connected with the passages, and a positively

actuated rotary distributing valve for controlling said passages whereby air is supplied alternately to the low pressure cylinders and from the latter to the chamber.

7. A pneumatic starter for engines as claimed in claim 1, in which a storage flask
25 is supplied with air from the high pressure cylinders, and means whereby air from the storage tank is supplied to the low pressure cylinders to drive the pistons therein.

In testimony that we claim the foregoing
30 as our invention, we have signed our names in presence of two subscribing witnesses.

ANTON HUWILER.
HARRY MAGGI.

Witnesses:

ARNOLD ZUBER,
FRANZ GRATZNEY.