C. BARBEY.

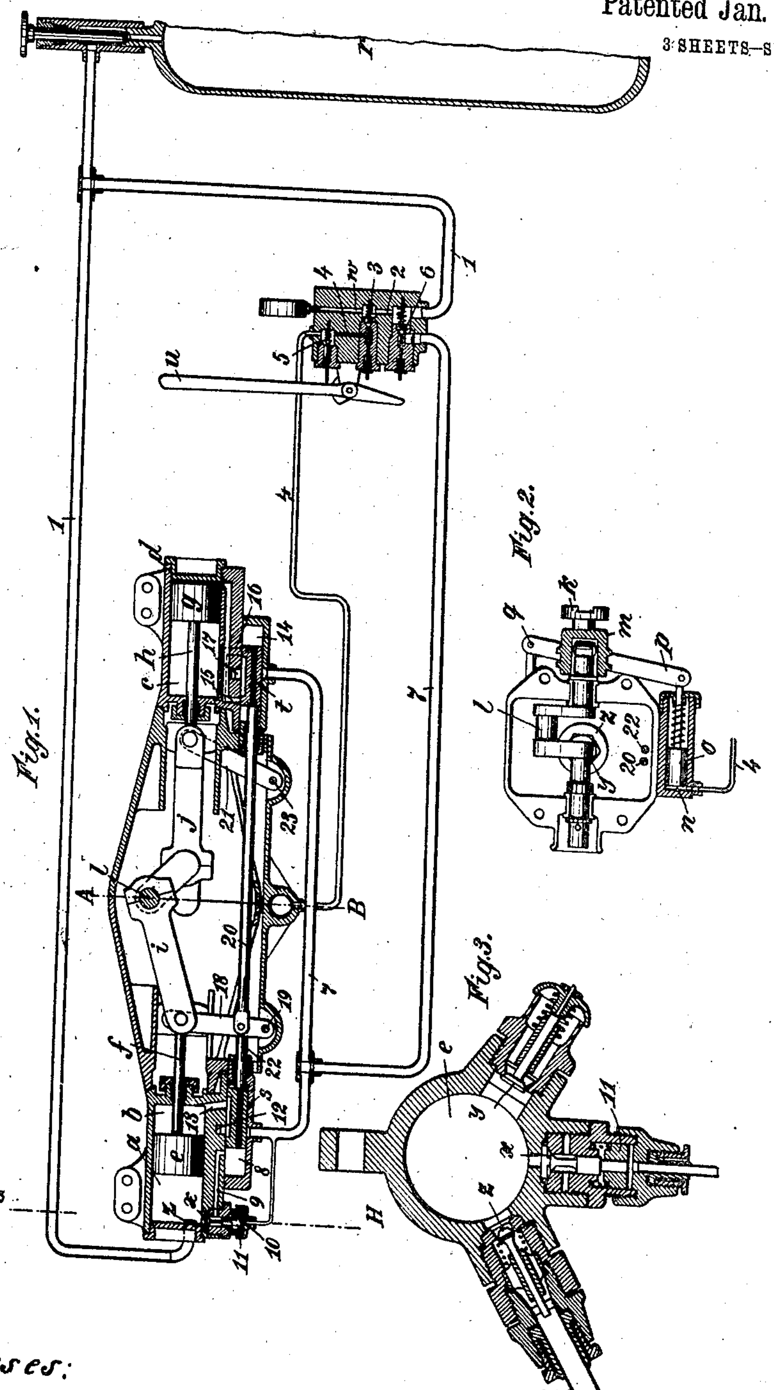
STARTING DEVICE FOR ENGINES.

APPLICATION FILED SEPT. 24, 1908.

1,013,723.

Patented Jan. 2, 1912.

3 SHEETS—SHEET 1.



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3 SHEETS—SHEET 2.

Fig. 4.

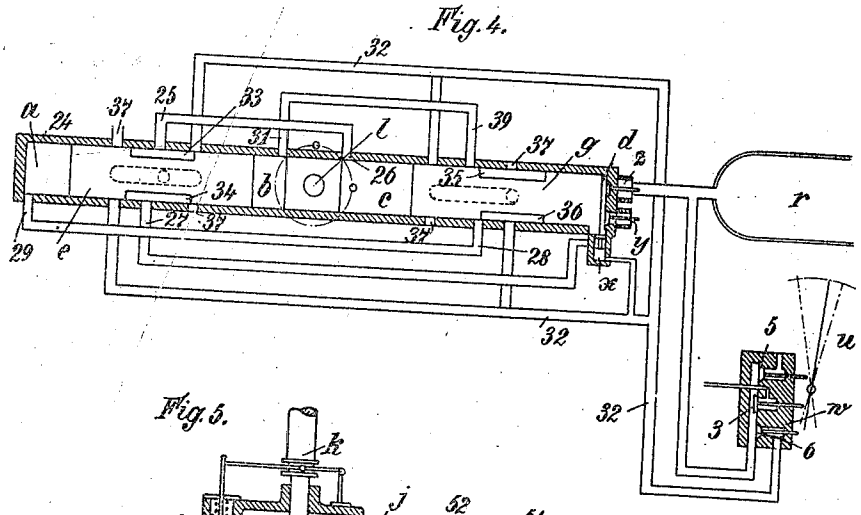
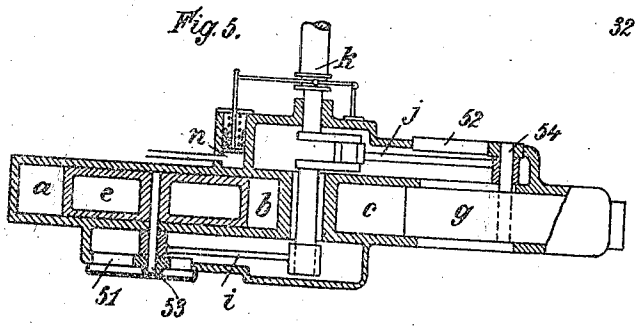


Fig. 5.



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3 SHEETS—SHEET 3.

Fig. 6.

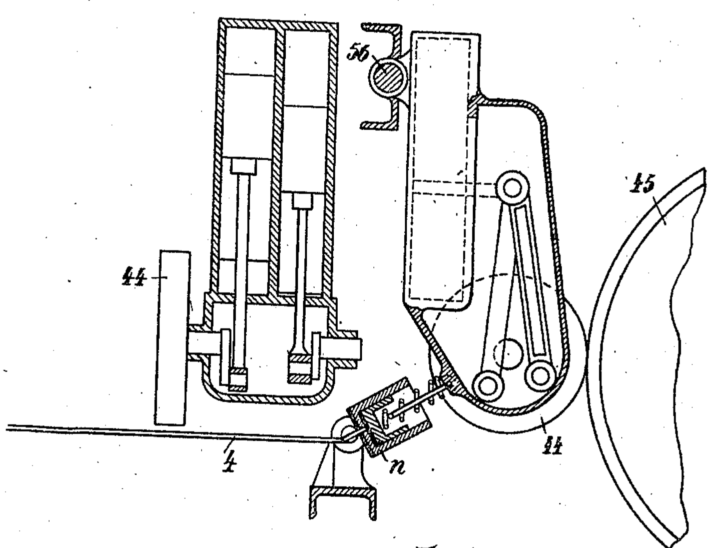
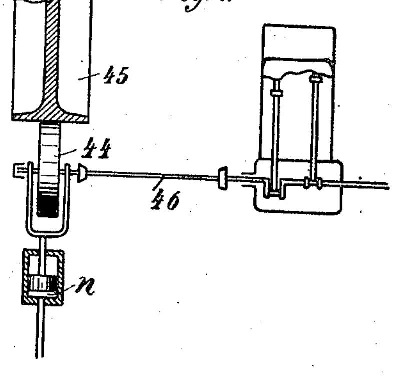


Fig. 7.



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UNITED STATES PATENT OFFICE.

CAMILLE BARBEY, OF GENEVA, SWITZERLAND.

STARTING DEVICE FOR ENGINES.

1,013,723. Specification of Letters Patent. Patented Jan. 2, 1912.

Application filed September 24, 1908. Serial No. 454,639.

To all whom it may concern:

Be it known that I, CAMILLE BARBEY, a citizen of the Swiss Republic, and residing at 5 Crets de Champel, Geneva, Switzerland, have invented a certain new and useful Starting Device for Engines, of which the following is a specification.

This invention relates to compressed air motors adapted to start the internal combustion motor on a motor-car and wherein the starting motor comprises two cylinders, one or both of which, as required, work either as compressor or motor, the starting device being connected to the engine by a coupling that can be disconnected. This coupling is operated by compressed air and is regulated by a valve which couples and uncouples it. The cylinders which can work both as compressors and as motors, have suction and delivery valves and furthermore each is provided with a distributing valve by means of which the work of the cylinder as a motor can be regulated.

The valve motion of the starting motor when working as a motor comprises a three ported slide valve in each cylinder. Each of these valves is operated by the piston rod of the other cylinder so that each of the valves perform two half strokes while the corresponding piston performs a full stroke.

In the accompanying drawings Figure 1 illustrates in section the general arrangement of one form of the invention, with the cylinders fitted with triple ported slide valves. Fig. 2 is a cross section on the line A—B of Fig. 1. Fig. 3 is a vertical section on the line G—H of Fig. 1 on a larger scale. Fig. 4 illustrates in section the general arrangement of another form of the invention wherein the pistons of the starting motor act as the piston valves. Fig. 5 is a sectional plan showing the pistons and connecting rods of the starting motor shown in Fig. 4. Fig. 6 shows in partial section the general arrangement of a further form of the invention wherein a friction wheel is used for connecting the driving motor to the main motor. Fig. 7 shows the general arrangement of the starting motor and friction wheel mounted on a connecting shaft.

The form of starting motor illustrated in Figs. 1 to 3, comprises two opposed double acting cylinders *a*, *b*, and *c*, *d*, having pistons *e*, *g*, fitted with connecting rods, *i*, *j*, connected to two cranks arranged at 90 degrees to each other on a shaft *l*. The shaft, *l*, is adapted to be connected with the main shaft of the motor to be started by means of a clutch, *k*, and sleeve, *m*. Any number of cylinders may be used although an even number is preferred. They may be arranged and connected in groups as desired and may be single or double acting.

The cylinder space, *a*, is intended to act as a compressor until sufficient compressed air is supplied to the reservoir, *r*, after which when the motor is acting as a starting motor it also can work as motor; the cylinder spaces, *b*, *c*, *d*, being only intended to work as motor spaces or cylinders. When the space, *a*, is working as a motor cylinder it is controlled by a triple-ported slide valve, *s*, and by a distributing valve, *x*, but when it has to work as a compressor then the spring controlled suction and delivery valves, *y* and *z*, come into operation. The cylinder spaces, *b*, and *c*, are controlled by the slide valves *s* and *t*. The slide valves, *s* and *t*, are ordinary triple-ported slide valves each having one exhaust port. Compressed air from the pipe 7, passes to the slide valve *s*, and thence to the cylinder spaces, *a*, *b*, through the inlet ports 9 and 13. 12 is the exhaust port communicating with the atmosphere. Compressed air from the pipe 7, also passes to the slide valve, *t* and thence to the cylinder spaces, *c d*, through the inlet ports 15, 16. The exhaust port is 17 and communicates with the atmosphere.

The slide valve *t* is operated by the valve rod 20 which latter is actuated by the lever 18 pivoted at 19 and rocked by the cross head of the piston rod *f*. The slide valve *s* is actuated by the rod 22, which is operated by the lever 21 pivoted at 23 and rocked by the cross head of the piston rod *h*. The inlet port 9 communicates with the lower side of distributing valve *x*, which valve is adapted to be opened by compressed air from the pipe 7 acting on a piston 11, the valve *x* when open allowing compressed air to pass from the inlet port 9 to the cylinder space *a*. The air compressed in the cylinder space *a* passes out by the delivery valve *z*, through the pipe 1 into the reservoir *r*, and also into the valve box *w*. This valve box *w*, has three spring controlled valves 6, 3, 5, the spindles of which packed by suitable means, are controlled by the lever *u*. Compressed air can always pass from the pipe 1 to the valve 6 and by a passage 2 to the valve 3, and as long as the lever *u*, is not pressed

on the spindles of these valves they remain closed. The pipe 7 communicates with the valve 6 and leads to the valve chests of the valves *s*, *t* and to the piston 11 of the distributing valve *x*. At the rear of valve 3 a channel 4 leads to the valve 5 and to a pipe 4 which communicates with the clutch operating coupling cylinder, *n*. The opposite side of the valve 5, communicates with the atmosphere. The lever *u*, is so pivoted and constructed that when moved to the left it successively allows the valve 5, to close, and opens the valves 3 and 6. A clutch *k*, is connected with the shaft *l*, of the starting motor by a sleeve, *m*, having a part of its interior adapted to engage a rectangular part of the shaft having rounded-off edges. The sleeve, *m*, has a groove in which engage the studs of the forked lever, *p*. The lever, *p*, is actuated by a piston, *o*, in the cylinder, *n*, operated by compressed air passing from the valve box, *w*, through the pipe 4.

In a second form of starting motor as illustrated in Figs. 4 and 5, the triple-ported slide valves *s* and *t*, are dispensed with as the pistons *e* and *g*, act as valves, the inlet ports 25, 27, 39, 28, co-acting with slots 33, 34, 35, 36 in the pistons so as to control the supply and exhaust of the compressed air to and from both sides of the pistons *e* and *g*. The pistons *e* and *g*, have connecting rods *i* and *j*, (Fig. 5) the trunnions of which reciprocate in slots in the cylinder walls. These trunnions are firmly screwed into the middle of their respective pistons *e*, *g*, and the other ends, are guided by guide blocks 53, 54 in the slides 51, 52, the slides being integral with the cylinders.

Fig. 6 shows a third modification which differs from the two before mentioned forms of construction in the arrangement of the cylinder and the friction clutch. Here also two double acting pistons are provided each with two distributing slots and each piston arranged at 90 degrees with respect to one another. The distribution of compressed air may also be effected by two triple-ported slide valves as in the first form of construction.

The clutch consists of a friction roller 44, which comes into contact with a pulley or fly-wheel 45, of the engine, and of a cylinder, *n*, a piston in which presses the apparatus with the roller 44 against the pulley 45, inasmuch as the whole apparatus turns about the pivot 56. Thus it results that when the starting motor acts as a compressor the roller 44 is pressed against the pulley 45, with a force which is proportional to the compression work of the compressor and increases with it; thus when the starting device works as motor, then the pressure of the roller 44 on the pulley 45, will be proportional to the work to be performed. The cylinder *n* may be integral with the apparatus and be connected by a piston rod with an outer fixed point.

A fourth modification is shown in Fig. 7, in which the starting apparatus is fixed, and is connected with a friction roller 44 by a connecting shaft 46. The friction roller 44 is then connected directly with the cylinder *n* and the working of the whole device is exactly the same as above described with reference to Fig. 6.

The working of the starting device comprises three periods:—1. The period of rest. 2. The starting period. 3. The period of compression.

I shall now describe the period of rest. In the drawing, the apparatus is shown in the period of rest, that is to say the normal period of the whole apparatus when it is under normal pressure and ready for effecting the starting. The hand lever, *u*, is in its outer-position on the right and presses on the valve 5 (Fig. 1) thereby raising it from its seat. The port or passage thus communicates with the atmosphere. The clutch piston *o*, is drawn to the left by means of its spring and the lever *p*, disengages the clutch *k*. It thus follows that the whole apparatus remains stationary.

We now pass over to the starting period the lever, *u*, being pulled to the left. First the valve 5, is released and under the action of its spring is pressed against its seat. The pipe 4, and the cylinder *w*, are thus cut off from the atmosphere. On further movement of the hand lever, *u*, toward the left it presses against the valve 3 and raises it from its seat. Compressed air forces its way through the port or passage 2, into the pipe 4, presses the piston *o*, to the right and throws the clutch *k*, (Fig. 1) in engagement, the clutch being now ready to rotate the main shaft of the engine. On further movement of the hand lever *u*, toward the left it presses not only on valve 3, but also on valve 6. Compressed air forces its way from the pipe 1 into the pipe 7, passes to both the valve chests of the slide valves *s* and *t*, and also behind the piston 11 of the distributing valve, *x*, which is thus opened and effects constant communication with inlet port 9. The compressed air first presses on the surface of the slide valves *s t*, and forces its way into the inlet ports which are open. These inlet ports, 9, 13, 15, 16 are so arranged that the rotary movement of the apparatus is effected in the prescribed direction, in the example given, in the direction of the hands of a clock and without any dead center. In this particular arrangement the inlet ports of one of the cylinders, in this case of the cylinder *c*, *d*, must be crossed in relation to the inlet ports of the other cylinder, that is to say the left hand inlet port in the valve face leads to the inlet port of the opposite end of the cylinder.

Further by this method of distribution a constant feed during the whole stroke is effected by simple means, as the cranks are arranged at 90 degrees to each other and each piston is connected with the slide valves of the other piston so that each slide valve performs two strokes while the corresponding piston performs one reciprocation. A constant supply and exhaust of air is obtained owing to the central position of the outlet port between both inlet ports, and this is indispensable for a starting motor. The shaft *l* of the apparatus will also be rotated, and in the form of construction shown will rotate in the direction of the hands of a clock and by intermediary of the clutch will also rotate the main shaft of the engine to be started. The lever *u* after the starting has been effected, is again moved back toward the right, the valve 6 closes and cuts off the pipe 7 and piston 11 from the compressed air. The lever *u* however, still presses on the rod of the valve 3, so that the latter remains open. The machine is now in the compression period, in which the pipe 4 is still filled with compressed air and the clutch *k* is still engaged. The engine consequently rotates the shaft of the starting motor and the part *a* acts as a compressor by means of the suction and delivery valve *y*, *z*, while the distributing valve *x* is held closed by means of its spring. The three cylinder spaces *b*, *c*, *d*, work under no load and without resistance, as on each change of stroke, they communicate by means of their slide valves *s*, *t*, with the exhaust ports 12, 17. The compression period lasts until the required pressure is indicated on the manometer of the valve box *w*, then the lever *u* is moved farther to the right until its presses against the valve rod 5 after having closed the valve 3. The compressed air which is contained in the pipe 4 and cylinder *n* escapes into the atmosphere, and the clutch *k* is disengaged. The apparatus is now again in the period of rest.

The working periods of the other modifications are theoretically the same, only the mechanical components of the pistons, connecting rods and distribution are different.

In the second modification Figs. 4 and 5 the valve box *w* is the same as in the first form of construction; the pipe 32 corresponding to the pipe 7 of Fig. 1. When the apparatus works as a compressor (Fig. 4) then the air in the cylinder space *d* for example, is compressed in the usual way. When the apparatus has to work as a motor, then the lever *u* of the valve *w* is pushed to the right, compressed air rushes into the pipe 32 and through the piston slots 33, 34, 35, 36, into the inlet ports 25, 27, 39, 28, (for example in Fig. 4) through 33 into 25 and through 36 into 28, whereby the cylinder spaces *a* and *c* receive compressed air and the shaft *l* is turned in a clockwise direction. At the same time the ports 27, 31, communicate by means of 37 with the atmosphere through the slots 34, 36, and the compressed air escapes from the spaces *b* and *d*. The channel 27 communicates with the distributing valve *x* as in the first form of construction.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:—

1. An auxiliary motor for starting a main internal combustion motor and comprising a crank shaft, a cylinder, a piston in the cylinder adapted to drive the crank shaft, a main motor, a clutch between the auxiliary and main motors, a compressed air receiver, a valve box, a plurality of valves in the box, pipe connections from the box to the receiver, to the auxiliary motor cylinder, to the clutch and from the cylinder to the receiver, means in communication with the cylinder and receiver for causing the auxiliary motor to work as a pump and means for so successively operating the valves in the box that the clutch is first operated, then the auxiliary motor is started, and when starting has been accomplished, the driving force of the auxiliary motor is first cut off, upon which the auxiliary motor is driven by the main motor to act as a compressor and finally the auxiliary motor is de-clutched from the main engine.

2. An auxiliary motor for starting a main internal combustion motor, and comprising a plurality of cylinders, a crank shaft, a piston in each cylinder, a connecting rod for each piston and so working upon the common crank shaft that "dead centering" is prevented, a main motor, a clutch between the auxiliary and main motors, a compressed air receiver, a valve box, a plurality of valves in the box, pipe connections from the box to the receiver, to the auxiliary motor cylinders, to the clutch and from the cylinder to receiver, means in communication with the cylinder and receiver for causing the auxiliary motor to work as a pump, and a lever for so successively operating the valves in the box that the auxiliary motor may drive the main engine by the clutch or the main engine may drive the auxiliary motor so that the latter may compress air.

3. An auxiliary motor for starting a main internal combustion motor, and comprising a plurality of cylinders, a crank shaft, a piston in each cylinder, a connecting rod for each piston and so working upon the common crank shaft that dead centering is prevented, a main motor, a clutch between the auxiliary and main motors, a compressed air receiver, a valve box, a plurality of valves in the box, pipe connections from

the box to the receiver, to the auxiliary motor cylinders, to the clutch and from the cylinder to the receiver, means in communication with the cylinder and receiver for causing the auxiliary motor to work as a pump, and a lever for so controlling the valves in the box that the auxiliary motor may drive the main engine through a clutch, or the latter may drive the former to compress air in one of the cylinders and means whereby air may be drawn into and discharged from one of the cylinders to the receiver.

4. An auxiliary motor for starting a main internal combustion motor, and comprising a plurality of cylinders, a crank shaft, a piston in each cylinder, a connecting rod for each piston and so working upon the common crank shaft that "dead centering" is prevented, a main motor, a clutch between the auxiliary and main motors, a compressed air receiver, a valve box, a plurality of valves in the box, pipe connections from the box to the receiver, to the auxiliary motor cylinders, to the clutch and from the cylinder to the receiver, means in communication with the cylinder and receiver for causing the auxiliary motor to work as a pump, and a lever for so successively operating the valves in the box that the clutch will first be actuated and then the auxiliary motor will be started to drive the main engine with a clutching force which will be proportional to the work to be performed and when starting has been accomplished the driving force of the auxiliary motor is first cut off, upon which said motor will be driven by the main engine to work as a compressor with a clutching force proportional to the compression work of the compressor and increasing with it and the auxiliary motor being finally de-clutched from the main engine.

5. Apparatus for starting internal combustion motors comprising in combination a plurality of cylinders, a crank shaft, a piston in each cylinder, a connecting rod to each piston working upon the crank shaft, a compressed air receiver, a slide valve for each cylinder, a valve box, connections from the valve box to the slide valves, inlet and outlet ports in the cylinders, a connection from the valve box to the receiver and from the end of one cylinder to the receiver, and means in and on the valve box to start and stop the starting motor or to permit one cylinder to compress air into the receiver.

6. Apparatus for starting internal combustion motors comprising a pair of cylinders, pistons therein, slide valves therefor and connecting rods actuating a common crank shaft, the combination therewith of a compressed air receiver, a valve box, connections from the box to the slide valves and a connection from the receiver to the end of one cylinder inlet and outlet ports for the cylinders, the ports in one cylinder being crossed, air inlet and outlet valves in the end of one cylinder, a cut-off valve adjacent to the inlet and outlet valves, and means in and on the valve box to start and stop the starting motor or to permit one cylinder to compress air into the receiver.

7. Apparatus for starting internal combustion motors comprising a pair of cylinders, pistons therein and slide valves therefor, a common crank shaft with cranks arranged relatively at 90° and connecting rods between the shaft and pistons, the slide valve of one cylinder being actuated from the piston in the opposite cylinder, the combination therewith of a compressed air receiver, a valve box, connections from the valve box to the receiver, and from the box to the slide valves, and means in and on the valve box to start and stop the starting motor or to permit one cylinder to compress air into the receiver.

8. Apparatus for starting internal combustion motors comprising in combination, a pair of cylinders, pistons therein and slide valves therefor, a crank shaft with cranks relatively arranged at 90°, connecting rods between the crank shaft and pistons, a main engine, a clutch between the main engine and the crank shaft, a compressed air receiver, a valve box, a plurality of valves in the box, pipe connections from the box to the receiver, to the auxiliary motor cylinders, to the clutch and from one of the cylinders to the receiver, means in communication with the cylinder and receiver for causing the auxiliary motor to alternately work as a pump, and a lever for so controlling the valves in the box that the clutch will first be actuated and then the auxiliary motor will be started to drive the main engine and when starting has been accomplished the driving force for the starting motor is first cut off upon which the starting motor will be driven by the main engine to compress air into the receiver and finally the starting motor will be de-clutched and stopped.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

CAMILLE BARBEY.

Witnesses:
FRANCIS B. KEENE,
F. VULLIN.