No. 868,014. PATENTED OCT. 15, 1907.

E. W. ROBERTS.

AUTOMOBILE.

APPLICATION FILED MAR. 17, 1905.

4 SHEETS—SHEET 1.

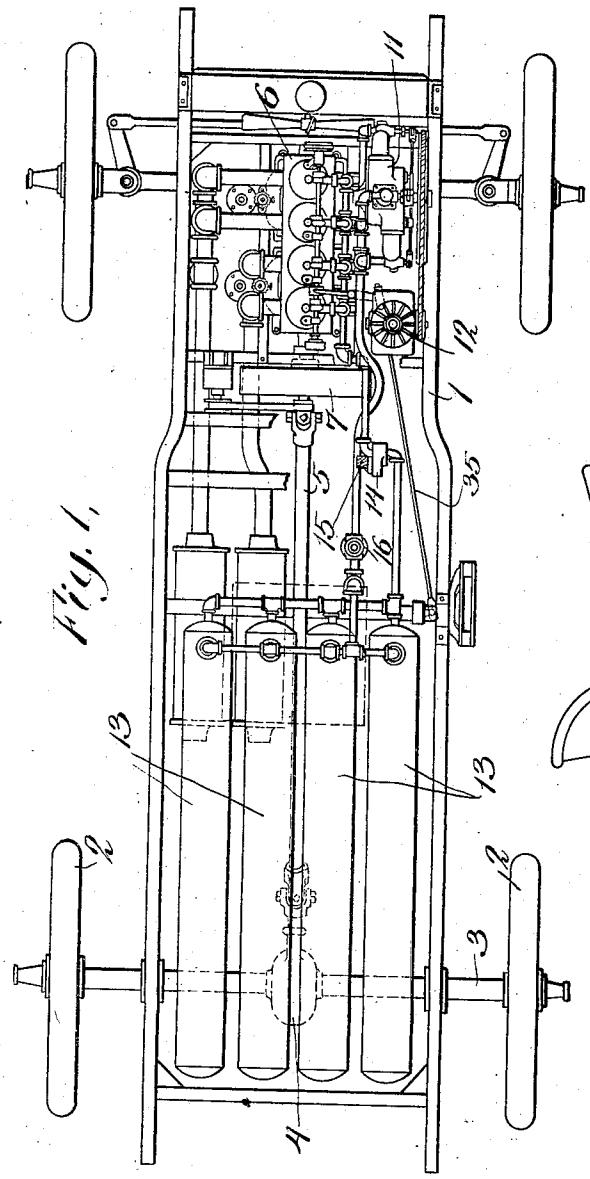

Fig. 1.

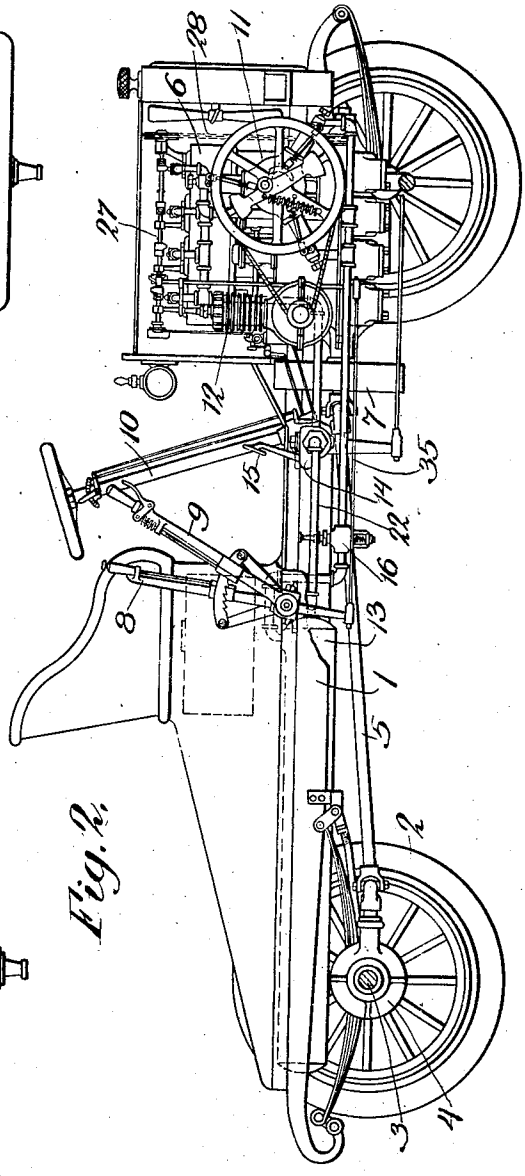

Fig. 2.

WITNESSES

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4 SHEETS—SHEET 2.

Fig. 5.

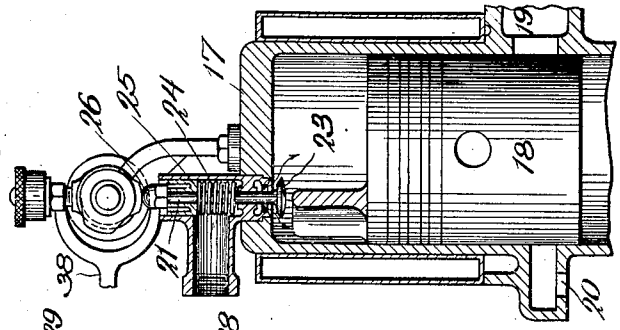


Fig. 3.

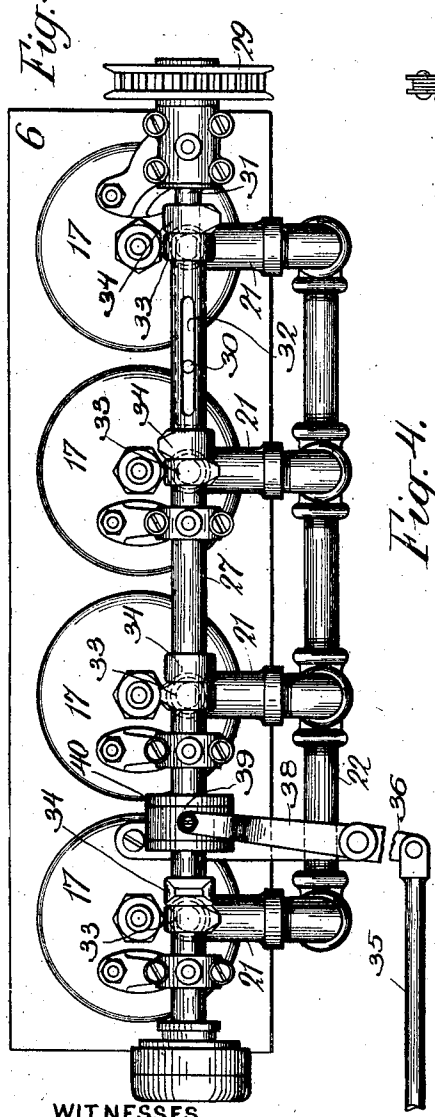
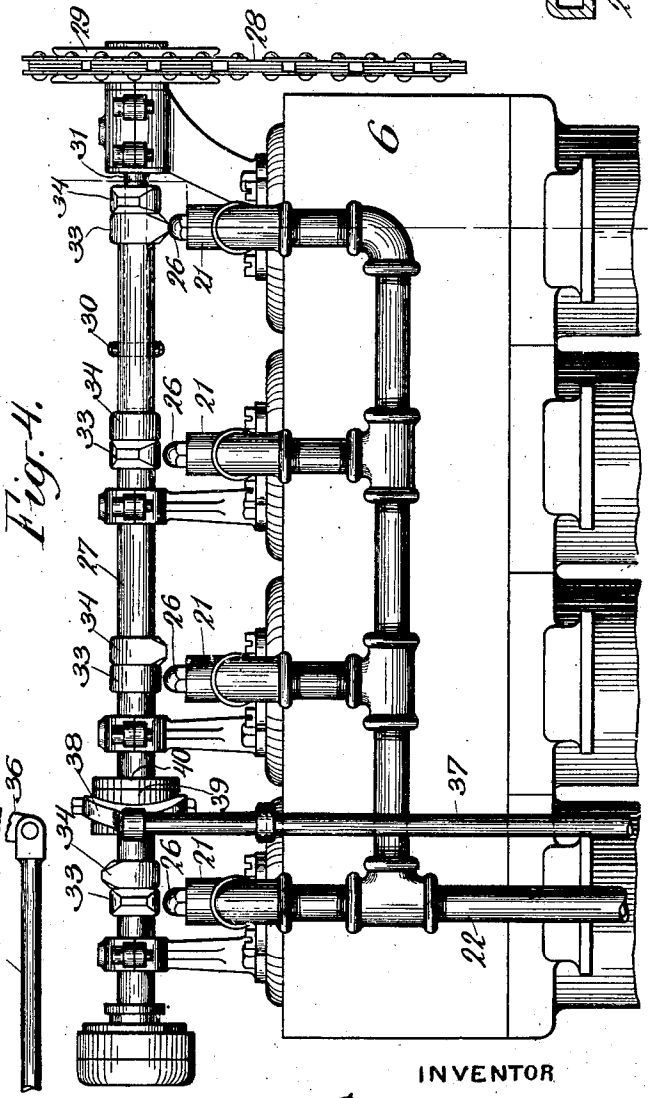


Fig. 4.



WITNESSES

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4 SHEETS—SHEET 3.

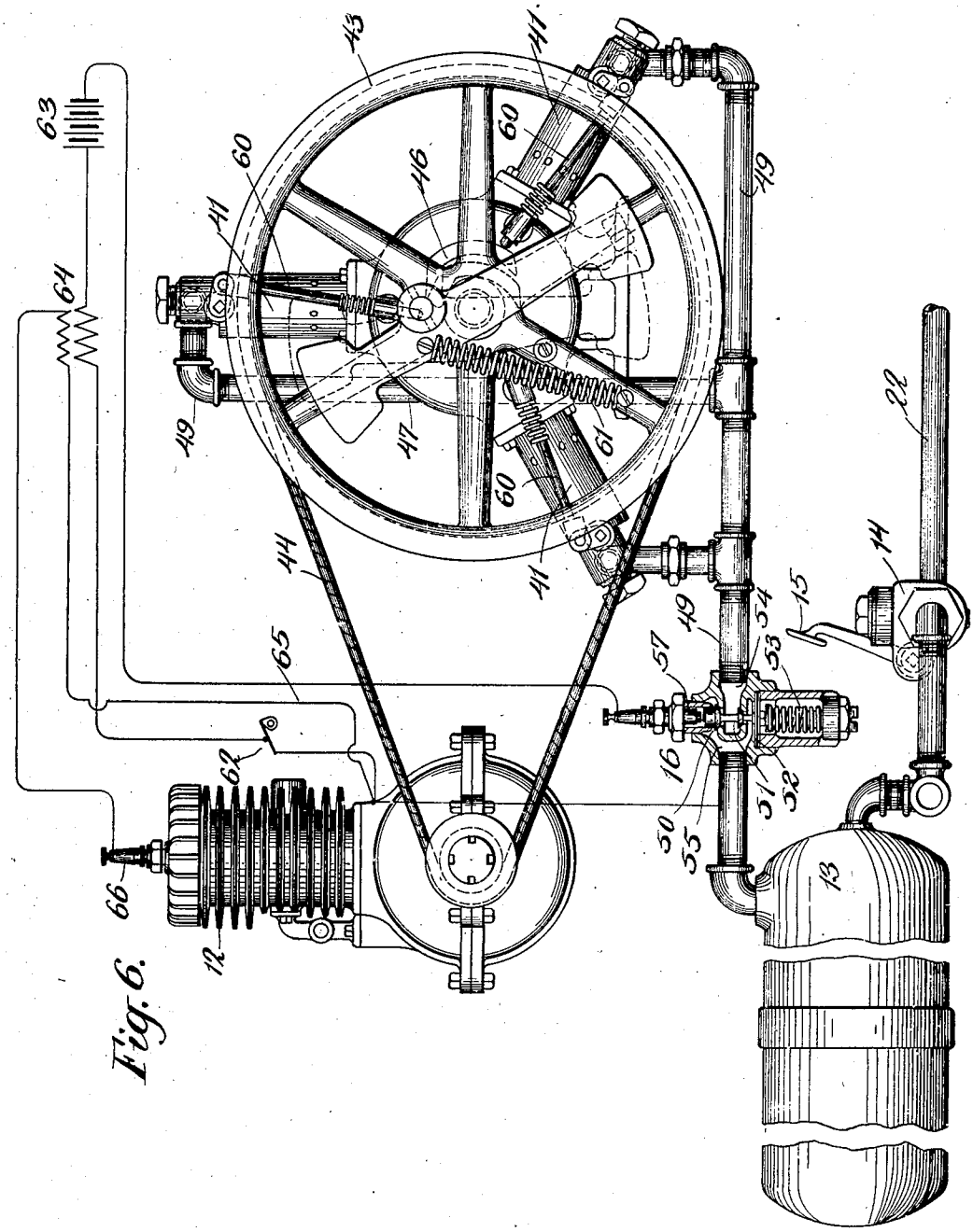

Fig. 6.

WITNESSES

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4 SHEETS—SHEET 4.

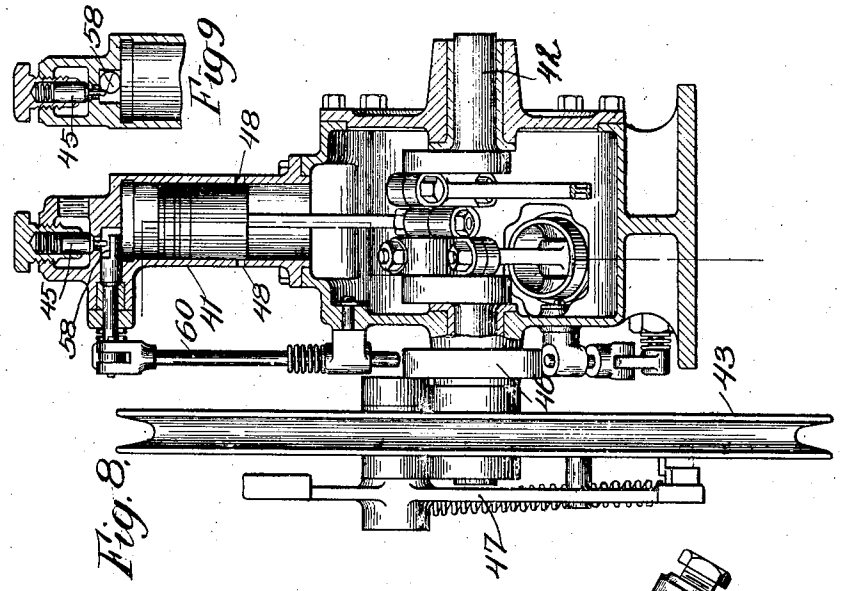

Fig. 9.

Fig. 8.

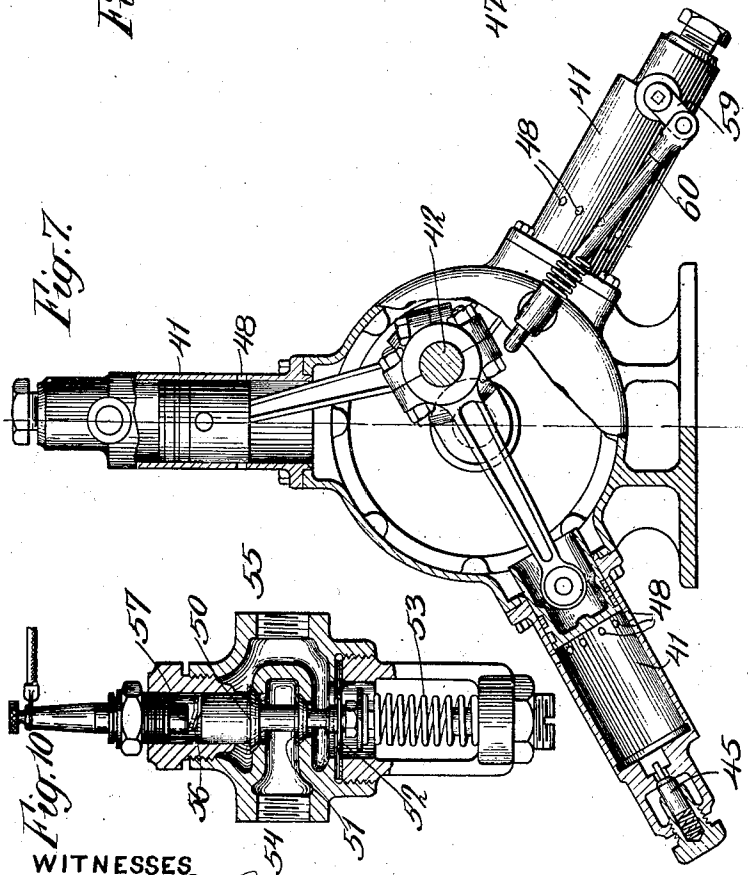

Fig. 7.

Fig. 10.

WITNESSES

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UNITED STATES PATENT OFFICE.

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AUTOMOBILE.

No. 868,014. Specification of Letters Patent. Patented Oct. 15, 1907.

Application filed March 17, 1905. Serial No. 250,503.

To all whom it may concern:

Be it known that I, EDMUND W. ROBERTS, a citizen of the United States, residing at Clyde, in the county of Sandusky and State of Ohio, have invented certain new and useful Improvements in Automobiles; and I do hereby declare the following to be a full, clear, and exact description of the same, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to improvements in automobiles, and particularly to that type thereof which have internal combustion engines for driving them. It is well known that such engines as employed in the past in automobiles, driving the vehicles directly or through gearing, are incapable of starting under load, or even, in most instances, of starting at all except by the application of power from outside, and are incapable of reversing; and this has necessitated the interposition of a clutch and reversing mechanism between the engine and the driving wheels of the vehicle—thereby unduly complicating the mechanism of the vehicle, increasing greatly the liability to derangement, making it difficult or impossible to start the vehicle without jerking, making it difficult to run the vehicle at low speed through streets crowded with other vehicles, and giving rise to disagreeable noise in the operation of the mechanism. Moreover, the clutch and reversing gear, and the accompanying change-speed gearing usually employed, require a number of operating devices, such as levers, pedals, etc., for their control, and the multiplicity of these control devices is apt to confuse the operator in an emergency.

The objects of my invention are to avoid the use of such transmission clutch, reversing gearing, etc., between the motor and the driving wheels of the vehicle, to permit the engine to be in permanent driving connection with the driving wheels, to provide for starting and reversing such a permanently-connected motor under load, to provide a reserve of power to enable the vehicle to overcome exceptionable obstacles, to permit easy and gentle starting and reversing of the vehicle under all conditions, to permit the vehicle to be maneuvered promptly and readily under all conditions encountered in crowded streets, to simplify the control devices of such vehicles, and generally to make the vehicle more simple, more reliable, more positive in operation, easier to control, and quiet in operation.

My invention consists in a wheeled vehicle having driving wheels and having in permanent operative connection with such driving wheels an internal combustion engine having a sufficient number of cylinders and provided with suitable valve gear to make it self-starting and self-reversing upon the admission of fluid under pressure; in the combination with such an engine, so connected to the wheels of a vehicle, of a separately-driven compressor provided with means for supplying to such engine fluid under pressure to start and reverse the engine under load; in automatic controlling devices for the compressor; and in other features hereinafter set forth and particularly pointed out in the claims.

I will now proceed to describe my invention with reference to the accompanying drawings, illustrating one embodiment thereof, and will then point out the novel features in claims.

In the said drawings, Figure 1 shows a top view of the chassis or running gear of an automobile constructed in accordance with my invention, the vehicle body and the bonnet having been removed. Fig. 2 shows a side elevation and partial vertical section of the vehicle, the side of the bonnet having been removed to show the main driving engine, the compressor and its auxiliary engine, and the control devices. Figs. 3, 4 and 5 are detail views of the main driving engine of the vehicle, Fig. 3 showing a top view of the engine, Fig. 4 showing a side view of the upper part of the engine, including the valve gear thereof, and Fig. 5 showing a vertical transverse section through one of the engine cylinders. Fig. 6 is a diagrammatic side elevation of the compressor, its driving engine, storage tank, and control devices, the controlling valve being shown in section. Fig. 7 is a partial side view and partial central vertical section of the compressor. Fig. 8 shows a central vertical section of the compressor, the section being taken at right angles to Fig. 7. Fig. 9 is a detail vertical section of the outer end of one of the compression cylinders, the section being taken at right angles to Fig. 8. Fig. 10 shows a central vertical section of the automatic controlling or starting and stopping valve of the compressor.

Referring now to the drawings, and at first more particularly to Figs. 1 and 2, numeral 1 designates the frame of the vehicle, 2 the driving wheels thereof, 3 the driving axle thereof, 4 the casing of the compensating gear with which motor vehicles are customarily provided, 5 a longitudinal propeller shaft, and 6 the main driving engine of the vehicle; which engine is arranged longitudinally of the vehicle, in the front part thereof, under a bonnet, as is customary, and as shown is in direct permanent driving connection with the propeller shaft 5; and so with the driving axle and wheels of the vehicle.

7 designates the engine flywheel. The particular vehicle shown is of the so-called "chainless" type, in which motion is transmitted to the axle through bevel gears located with the casing of the compensating gear; but such gears I do not show, as the arrangement in question is well known and understood to be present in a vehicle of this type. I do not limit myself however to the application of my invention to vehicles having a chainless drive, as the invention is applicable to any vehicle driven by an internal combustion motor, without regard to the particular type of drive employed.

The particular engine 6 shown is a four-cylinder combined compressed air and internal combustion engine, capable of operating either as an internal combustion engine, or as a compressed air engine, or as both simultaneously. Considered as an internal combustion engine, it is of the so-called "two-cycle" type, giving, in normal operation, four explosions for each revolution of the crank shaft; but the type of internal combustion engine, and number of cylinders, are both unimportant, all that is required being that the engine shall have enough cylinders to be capable of self-starting under load, running as a compressed air motor, when fluid under pressure is supplied to it for that purpose.

A hand-lever 8 is provided for shifting the cam-shaft of the valve gear, for starting and reversing the vehicle, and the usual brake lever 9 and steering gear 10 are also provided. For supplying air under pressure for starting and reversing the engine, and for running with compressed air, the vehicle is provided with an air compressor 11, driven by an auxiliary internal combustion engine 12, and with storage tanks 13, a throttle valve 14 operated by a foot-pedal 15 and controlling the flow of air under pressure from said tanks to the engine 6, and an automatic pressure-actuated valve 16 controlling the operation of the air-compressor.

Referring now to Figs. 3, 4 and 5, 17 designates the cylinders of the main or driving engine, 18 a piston of one of said cylinders, 19 an exhaust port of one of the cylinders, 20 the fuel admission port of such cylinder, and 21 a compressed-air admission valve for such cylinder. Each cylinder is provided with one of said valves, air under pressure being supplied to them by a pipe 22 containing the throttle valve 14 and connected to the storage tanks 13. Each of these air valves comprises a casing containing a puppet-valve 23 and a seat therefor, a spring 24 tending to hold said valve seated, and a balancing piston 25 secured to the stem of said valve and working within a corresponding cylinder comprised in the valve-casing. This balancing piston prevents the air-pressure from opening the valve, having slightly greater area than the valve; the spring 24 serving merely to hold the valve seated when for any reason the pressure is low. The end of the valve stem projects out above the valve-casing, and is provided with a rounded head 26. Above these heads of the valve-stems is located a cam-shaft 27, driven in a suitable manner from the crank shaft of the engine,—in the instance shown, driven by a sprocket chain 28, and sprocket wheel 29, though it may obviously be driven in various different ways. Said shaft is driven from the sprocket-wheel 29 through a key 30 (Fig. 3), carried by a shaft 31 secured to the sprocket-wheel and fitting within a hollow end of shaft 27, said key working in slots 32 of shaft 27, whereby longitudinal motion of the cam shaft, with respect to the sprocket-wheel, is permitted. Said cam-shaft carries two cams, 33 and 34, for each air-valve, cams 33 being for motion ahead, and cams 34 for motion backward; and by moving the cam-shaft forward or back, either set of these cams may be brought into operative position with respect to their corresponding valves, or the shaft may be moved to a position in which neither set of cams engages their respective valves. The valve-shaft is shifted, for this purpose, by means of the hand-lever 8, already mentioned, a rod 35 connecting said lever with a rocker arm 36 (Fig. 3) a rock-shaft 37 to which said arm is connected, and another rocker-arm 38 pivoted to a ring 39 running in a grooved collar 40 secured to the cam shaft. The cams are so designed and set that in whatever position the engine may stop, when the cam-shaft is moved to start in the desired direction, the proper one of the four air-valves 21 for starting in the desired direction will be opened, and as the cam-shaft rotates, the remaining air-valves will be opened in proper sequence to continue rotation in the desired direction. The sloping sides of the cams and rounded ends of the valve-stems permit the valves to be opened by lateral movement of the cams, when the engine is stationary.

Referring now to Figs. 6—10, showing the compressor, the particular type of compressor illustrated comprises three compression cylinders, 41, arranged about a common crank-shaft 42 driven by a belt-wheel 43 and belt 44 from the auxiliary engine 12. Inasmuch as I cause this compressor, at times, to act as an air-motor for starting its auxiliary engine 12, I provide the compression cylinders with admission valves 45, operated by suitable valve-gear comprising a cam 46 operated by a centrifugal governor-weight 47 on the belt-wheel 43. Valves 45 also serve as discharge valves of the compressor.

The compressor shown is of very simple type, having as few parts as possible. It has no valves, for admitting air to be compressed by the compressor. As the piston moves toward the crank-shaft, it draws a vacuum in the space behind it, until said piston uncovers ports 48 in the side of the cylinder. As soon as such ports are uncovered, the air rushes in. On the return stroke, compression begins when ports 48 are closed by the piston. When discharge pressure is reached, the spring-loaded discharge valve 45 at the end of the cylinder opens automatically and the compressed air is discharged into the pipe 49 leading to the storage tanks 13. The automatic controlling valve 16 in this pipe 49 is a double valve, having two connected plugs, 50 and 51, of different diameters, each plug of course having its corresponding seat, and having a diaphragm 52 exposed to receiver pressure and an adjustable spring 53 tending to raise the valves from their seats against receiver pressure. Valve plugs 50 and 51 being both exposed on one side to reservoir pressure and on the other side to pressure within the pipe 49, the pressures on the two valves tend to balance each other, but do not do so completely, owing to the different sizes of the valves. When the valves are closed, the pressure upon them assists the diaphragm 52 to resist the spring 53; but when said valves are open, they are surrounded on all sides by the same pressure and have no closing action. It follows, therefore, that when said valves have closed, there must be a considerable drop in pressure in the receiver or reservoir before said valves will open automatically. This provision is made in order that the valve may not be constantly opening and closing. 54 is the inlet to said valve from the compressor and 55 the outlet leading from said valve to the reservoir. Valve 16, besides controlling admission to the reservoir, is provided with means for stopping, as it closes, the auxiliary engine 12. For this purpose, the valve plugs carry a spring contact piece 56 which, when said valves are open, is in contact with a plug 57 insulated from the valve casing. As shown in Fig. 6, this valve

plug 57 and the casing of the valve, and therefore the spring 56, are included within the ignition circuit of the auxiliary engine.

The valve 16 opens when the pressure in the reservoir has fallen so low that the pressure from said reservoir on the diaphragm plus the effective pressure from said reservoir on the valve plugs 50 and 51, is not sufficient to overcome the upward thrust exerted by the spring 53. When the valve opens, contact will be closed between contact points 56 and 57, thus completing the ignition circuit of the auxiliary engine, as shown hereafter, and permitting compressed air to pass from the reservoir 13 through the valve 16 and pipe 49 to the compressor, for the purpose of running said compressor temporarily as a compressed air motor to start the auxiliary engine 12. In order that said compressor may serve temporarily as a motor, its cylinders are provided with cams 58 arranged when rocked to open valves 45. The stems of these cams project through suitable glands with ground joints and are provided with arms 59 to which are connected valve rods 60 suitably guided and spring-actuated toward the center. These valve rods are in position to be engaged by the cam 46 oscillated by the governor-weight 47. When this compressor is stationary, the governor-weight is in position shown in full lines in Fig. 6, the cam 46 being in position to engage said valve rods 60. Therefore, as soon as valve 16 opens and admits compressed air to pipe 49, one of the valves 45, being held open by cam 46, will cause the compressor to start as a compressed air motor, turning over the engine 12, and causing the latter to start. The ignition circuit of the engine 12 being closed, said engine will "pick up" almost immediately, and as soon as the compressor has reached a speed of say 200 revolutions, the governor-weight will have changed its position, under the influence of centrifugal force, and against the tension of its spring 61, to the position indicated in dotted lines, Fig. 6, the cam 46 being rocked so that it no longer engages the valve stems 60. The compressor will then cease to operate as an air engine and will operate as a compressor, compressing air through pipe 49 into the reservoir 13. As soon as the pressure in such reservoir, which now acts on the diaphragm only, becomes sufficient to overcome the pressure of spring 53, the valve 16 will close, breaking the ignition circuit of engine 12, and stopping said engine automatically.

Engine 12 is shown as provided with a jump spark ignition apparatus, the interrupter 62 of which is indicated diagrammatically in Fig. 6. The primary circuit is from the positive pole of battery 63 through induction coil 64 and the said interrupter to ground, as indicated by the frame of engine 12, and also by the pipe to which valve 16 is connected, and from the terminal of contact 57 of said valve back to battery. This primary circuit will be broken when valve 16 is closed, and will be closed, except when broken at interrupter 62, when valve 16 is open. The secondary circuit passes as usual from ground through conductor 65, and the induction coil 63 to the igniter plug 66 of the auxiliary engine.

The operation of the vehicle will now be described.

In starting initially with no pressure, or insufficient pressure in the reservoir 13 to start the auxiliary engine 12, the belt-wheel of the compressor may be turned over by hand, this being easy, because both the engine 12 and the compressor may be quite small. When so turned over, the engine 12 will start quickly, and gathering speed, the compressor will soon act to compress air into the reservoir 13. As soon as the pressure for which valve 16 has been adjusted has been reached, said valve will close, stopping the operation of the engine 12 and the compressor. For starting the vehicle, once sufficient pressure has accumulated in the reservoir 13, starting lever 8 is moved from its normal position to the position corresponding to the direction in which the vehicle is to be started, thus shifting the cam-shaft 27 so as to bring the proper set of cams into operative position, and opening the proper air valve 21 of the engine. At the same time, or immediately after, the pedal 15 is pressed, opening the throttle 14 and admitting air from the reservoir to the main engine 6. Said engine then begins to rotate as an air motor, moving the vehicle; but almost immediately the engine 6 "picks up" as an internal combustion engine, whereupon the throttle 14 may be closed and the starting lever 8 moved back into intermediate position. In practice, by properly priming the carbureter of the main engine and closing the ignition circuit thereof before opening the throttle 14, engine 6 will usually "pick up" so quickly as an internal combustion engine, that a mere kick upon the throttle, after the adjustment of the starting lever, is all that is required to start the vehicle; but if it is desired to start gradually, the operation of the engine as an internal combustion engine may be delayed by keeping closed the throttle valve in the fuel supply pipe, with which such engines are customarily provided, or by keeping the ignition circuit open, until the desired speed has been attained.

I customarily design and adjust the valve 16 to start the compressor when the pressure in the reservoir has fallen to 200 pounds to the square inch, and may cause the said valve to stop the compressor at any higher pressure between say 250 and 500 pounds per square inch. The higher the pressure normally maintained in the reservoir, the greater the reserve power available for overcoming exceptional obstacles. Thus it is easy to maintain in the reservoir a pressure which when admitted to the engine cylinders, running under compressed air alone, or under compressed air and internal combustion simultaneously, will give a mean effective pressure in the engine cylinders, twice or more than twice that which would be obtained when running under internal combustion alone. The reserve power for starting under heavy load and on steep grades and for overcoming exceptional obstacles, is, therefore, very great. It is easy to provide sufficient storage capacity so that the vehicle may be run a considerable distance on compressed air alone. Customarily, when the engine is reversed, the vehicle is run backward under air pressure only; but it is of course easy to cause the engine to run backward under power derived from internal combustion as well, all that is necessary to do this being to adjust the ignition lead properly.

It will be noted that the admission of air under pressure in the cylinders of engine 6, for the purpose of running said engine as an air motor, does not interfere in any way with the simultaneous operation of that engine as an internal combustion engine. This I have

demonstrated in actual practice. It is practicable for each of the engine cylinders to act simultaneously as the cylinder of an internal combustion engine and as the cylinder of a compressed air motor, because the air valves do not open until at or about the beginning of the down stroke of the piston, while the explosive charge is received in the cylinder, compressed, and customarily is ignited, during the preceding or up-stroke of the piston.

It is obvious that my invention is susceptible of many variations and modifications; that various forms of valve gear may be employed; that internal combustion engines other than those of the two-cycle type may be employed; that various forms of air compressors and that various means for driving the same and controlling the operation thereof may be employed. Therefore I do not limit myself to any of the details of construction and arrangement herein illustrated and described.

Since both the main engine 6 and the auxiliary engine 12 are of the same type, they may, and customarily will, take their fuel from the same source of supply—an important advantage.

By suitably regulating the tension of the governor-spring 61 of the compressor, said compressor may be caused to cease to operate as an air motor at whatever speed may be selected.

What I claim is:—

1. In an automobile, the combination with running gear comprising a driving wheel, of a combined internal combustion and compressed-fluid multi-cylinder engine in permanent driving connection with such driving wheel, said engine comprising cylinders serving normally as cylinders of an internal combustion engine and provided with valves and valve gear for admitting fluid under pressure to said cylinders to operate the engine as a self-starting compressed-fluid motor, the cylinders and associated parts and valve gear arranged to produce at least three impulses per revolution when operated as a compressed-fluid engine, and means for supplying fluid under pressure to said engine comprising a reservoir, a compressor, an auxiliary internal combustion driving engine therefor, and automatic controlling means operated by rise and fall of pressure in said reservoir and controlling the operation of said compressor engine and comprising automatic starting means therefor.

2. In an automobile, the combination with running gear comprising a driving wheel, of a combined internal combustion and compressed-fluid mutil-cylinder engine in permanent driving connection with such driving wheel, said engine comprising cylinders normally serving as cylinders of an internal combustion engine and provided with valves and valve gear for admitting fluid under pressure to said cylinders to operate the engine as a self-starting compressed-fluid motor, the cylinders and associated parts and valve gear arranged to produce at least three impulses per revolution when operated as a compressed-fluid engine, and means for supplying fluid under pressure to said engine comprising a reservoir, a compressor, an auxiliary internal combustion driving engine therefor, and automatic stopping and starting means for said auxiliary engine operated by rise and fall of pressure in said reservoir.

3. In an automobile, the combination with running gear comprising a driving wheel, of a combined internal combustion and compressed-fluid multi-cylinder engine in permanent driving connection with such driving wheel, said engine comprising cylinders normally serving as cylinders of an internal-combustion engine and provided with valves and valve gear for admiting fluid under pressure to said cylinders to operate the engine as a self-starting compressed-fluid motor, the cylinders and associated parts and valve gear arranged to produce at least three impulses per revolution when operated as a compressed-fluid engine, and means for supplying fluid under pressure to said engine comprising a reservoir, a compressor, an auxiliary driving engine therefor, and automatic means operated by rise and fall of pressure for starting the compressor as a compressed-fluid motor, and through it for starting said auxiliary engine, and for stopping said auxiliary engine.

4. In a system of automatic propulsion, the combination with running gear comprising a driving wheel, of a combined internal-combustion and compressed-fluid self-starting and self-reversing engine provided with auxiliary valve gear for starting and reversing the engine under load as a compressed-fluid engine, said engine having a suitable number of cylinders, and the said auxiliary valve gear being suitably arranged, to produce at least three impulses per revolution when said engine is operated as a compressed fluid engine, an auxiliary internal-combustion engine and compressor for supplying air under pressure to said engine, an intermediate air-tank, and automatic controlling means operated by fluctuations in air pressure and comprising means for stopping said auxiliary engine and for admitting air from said tank to said compressor to start same as a motor and through it said auxiliary engine.

5. In a system of automobile propulsion, the combination with running gear comprising a driving wheel, of a combined internal-combustion and compressed-fluid self-starting and self-reversing engine provided with auxiliary valve gear for starting and reversing the engine under load as a compressed-fluid engine, an auxiliary internal-combustion engine and compressor for supplying air under pressure to said engine, said auxiliary engine and compressor being self-starting and having an electric ignition circuit, and automatic pressure-operated means for interrupting said ignition circuit at a predetermined pressure and for starting said compressor as an air motor for the auxiliary engine and completing said ignition circuit at another predetermined pressure.

6. In a system of automobile propulsion, the combination with running gear comprising a driving wheel, a combined internal-combustion and compressed-fluid self-starting engine for driving said wheel, and means for connecting the engine thereto, said engine provided with auxiliary valve gear for starting the engine as a compressed fluid engine, of an auxiliary internal combustion engine and a compressor driven thereby for supplying air under pressure to said engine, and automatic controlling means operated by fluid pressure and comprising means for stopping the operation of the auxiliary engine at a predetermined pressure and for admitting fluid under pressure to start said compressor at another predetermined pressure to said compressor as a compressed fluid motor, and through it the auxiliary engine.

7. In a system of automobile propulsion, the combination with running gear comprising a driving wheel, a combined internal-combustion and compressed-fluid self-starting engine for driving said wheel, and means for connecting the engine thereto, said engine provided with valve gear for starting it as a compressed fluid engine, of an auxiliary internal combustion engine and a compressor driven thereby for supplying air under pressure to said engine, automatic controlling means operated by fluid pressure and comprising means for stopping the operation of the auxiliary engine at a predetermined pressure and for admitting fluid under pressure to said compressor at another predetermined pressure to start said compressor as a compressed fluid motor, said compressor comprising automatic centrifugal governing means and valves operated thereby.

In testimony whereof I affix my signature, in the presence of two witnesses.

E. W. ROBERTS.

Witnesses:

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H. M. MARBLE.