H. M. HALLSWORTH.

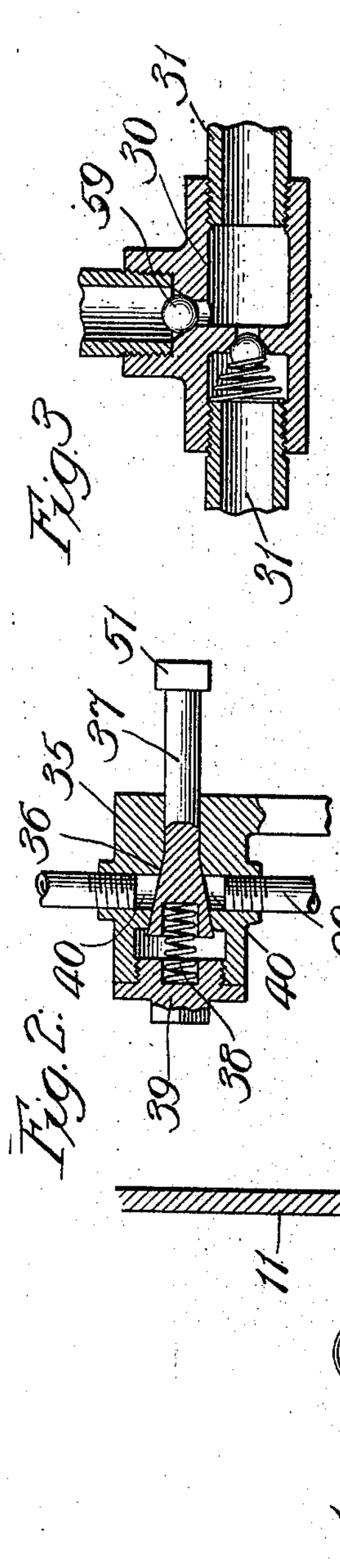
STARTING MECHANISM FOR INTERNAL COMBUSTION ENGINES.

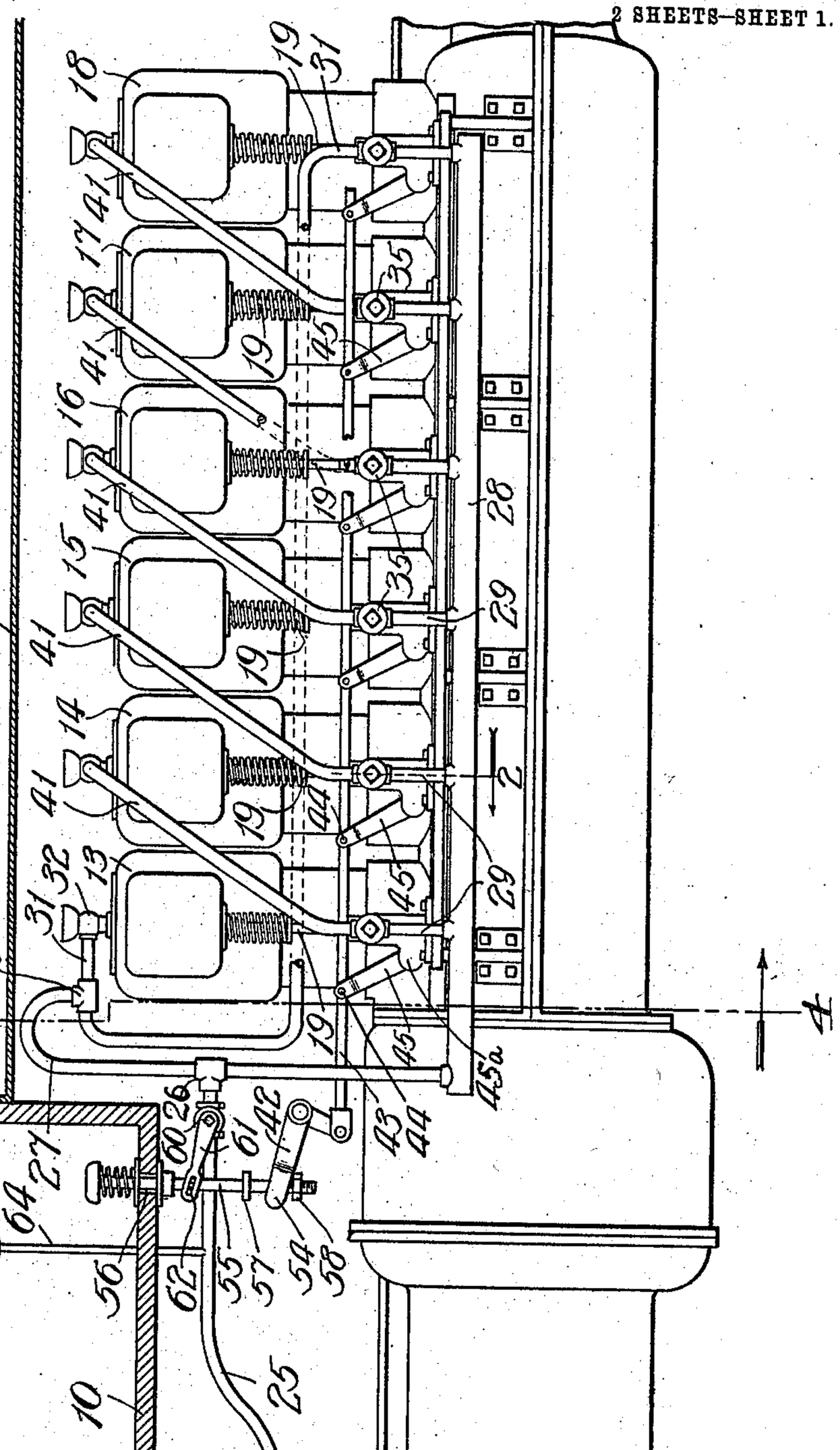
APPLICATION FILED AUG. 19, 1910.

989,963.

Patented Apr. 18, 1911.

2 SHEETS—SHEET 1.





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2 SHEETS—SHEET 2.

Fig. 5.

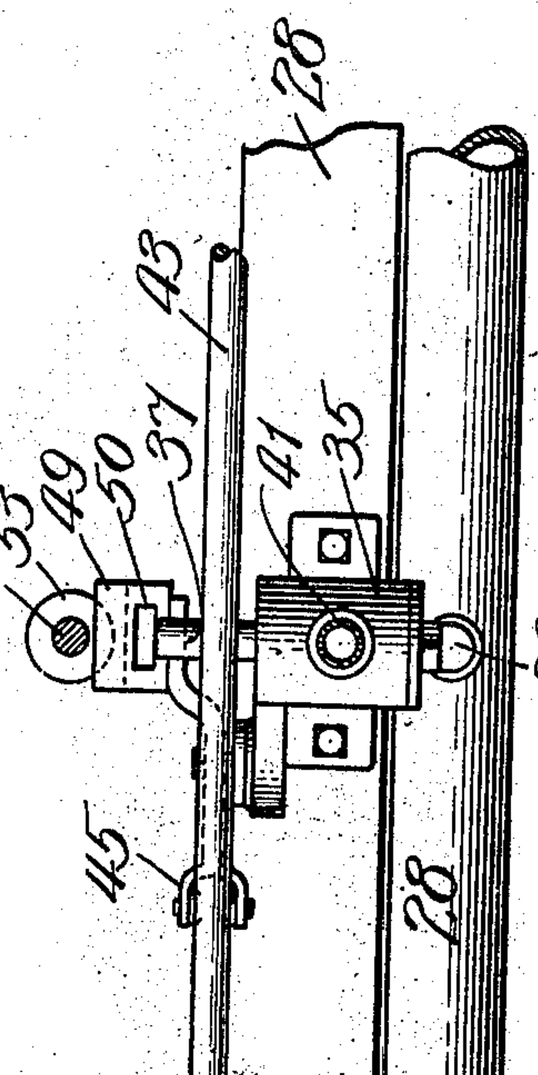


Fig. 6.

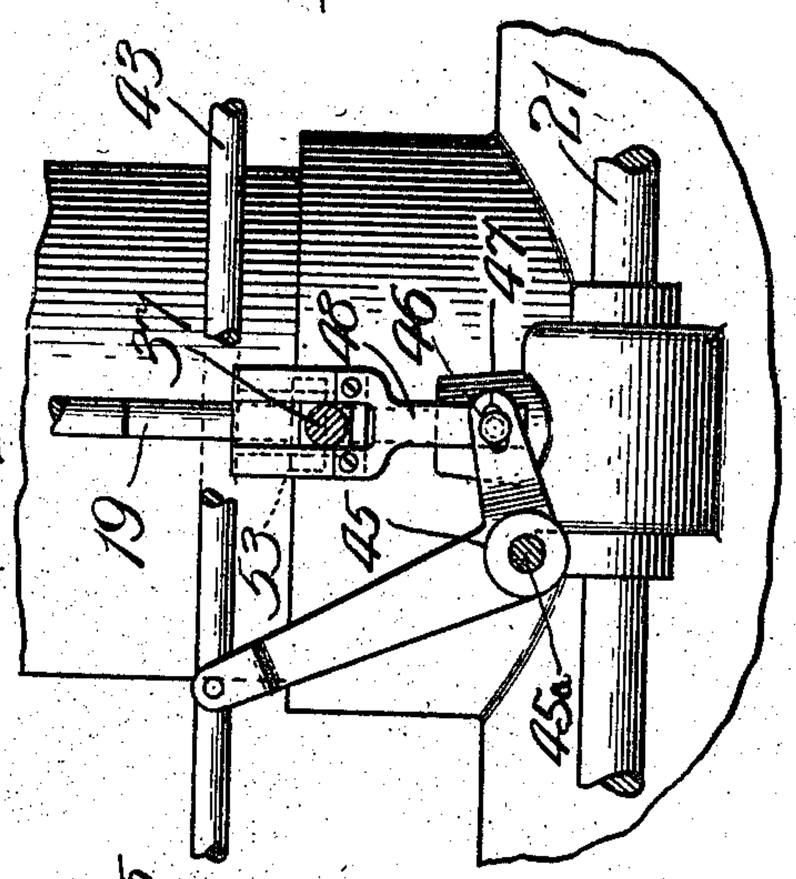
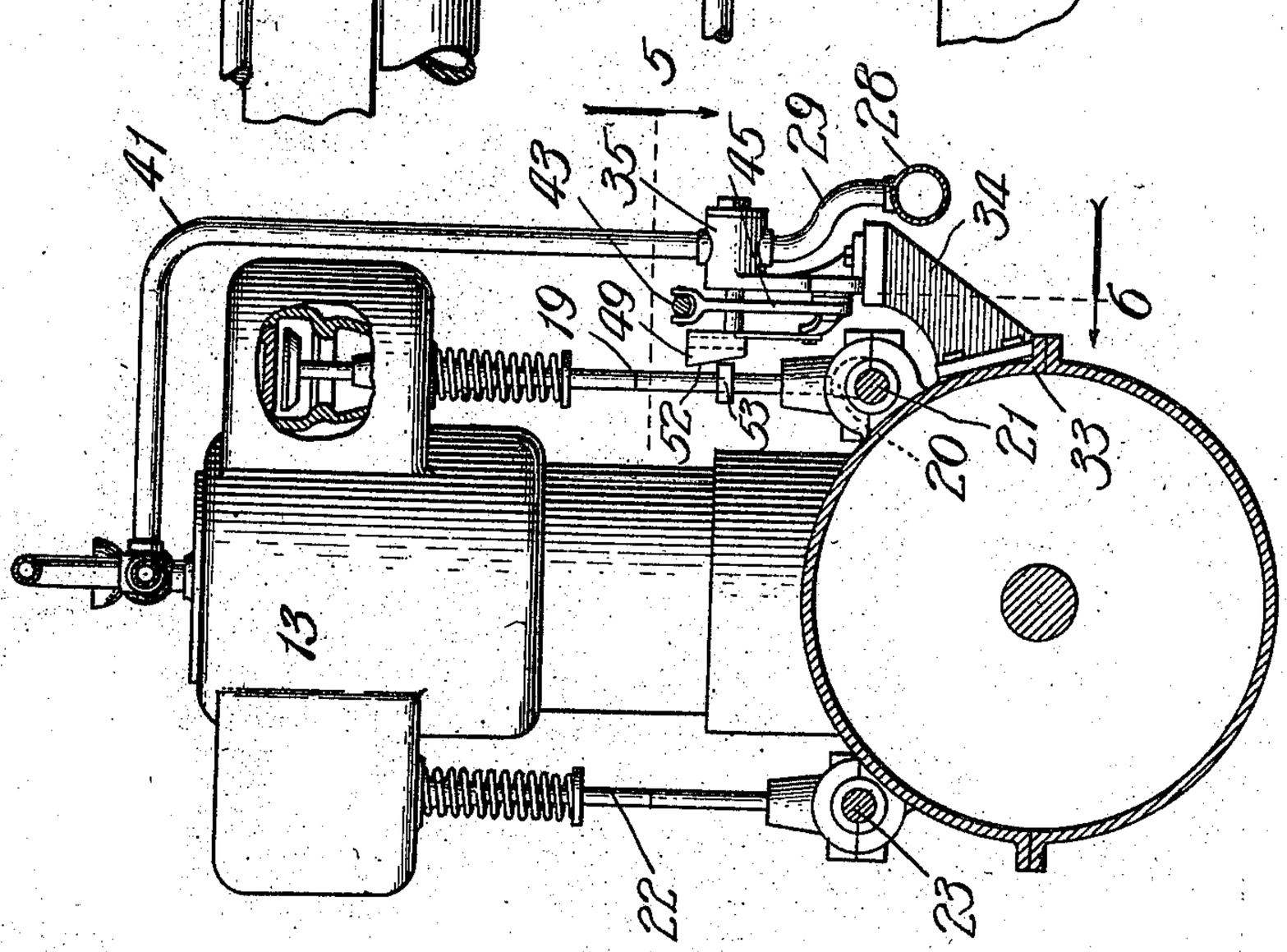


Fig. 4.



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UNITED STATES PATENT OFFICE.

HERBERT M. HALLSWORTH, OF RIVERSIDE, ILLINOIS.

STARTING MECHANISM FOR INTERNAL-COMBUSTION ENGINES.

989,963. Specification of Letters Patent. **Patented Apr. 18, 1911.**

Application filed August 19, 1910. Serial No. 577,926.

To all whom it may concern:

Be it known that I, HERBERT M. HALLSWORTH, a subject of the King of England, residing at Riverside, in the county of Cook and State of Illinois, have invented a new and useful Improvement in Starting Mechanism for Internal-Combustion Engines, of which the following is a specification.

My invention relates to improvements in devices employed in connection with internal combustion engines for starting the latter through the medium of compressed fluid-pressure whereby manual cranking of the engine is avoided; and my objects, generally stated, are to provide a simple and economical construction of starting mechanism of the character above referred to which will be positive in operation and which, when the engine is normally operating, will not be subjected to wear of its parts.

A further object is to provide a construction of starter which may be readily applied to existing engines without necessitating the remodeling or reconstruction of the parts of the latter, and a still further object is to generally improve upon starting devices as hitherto provided, to the end of rendering them better adapted for performing their functions.

Referring to the accompanying drawings—Figure 1 shows, by a view in side elevation, a portion of an automobile provided with a 6-cylinder engine equipped with starting mechanism constructed in accordance with my invention, the parts of the automobile illustrated being shown in section. Fig. 2 is an enlarged section taken at the line 2 on Fig. 1, this view showing the internal construction of one of the plurality of similar valves for controlling the flow of fluid-pressure to the cylinders, one of each of which valves is provided for each cylinder. Fig. 3 is a view in sectional elevation of check-valve mechanism in the conduits leading from a compression-tank and one of the valves illustrated in Fig. 2 to one of the cylinders. Fig. 4 is an enlarged section taken at the line 4 on Fig. 1 and viewed in the direction of the arrow. Fig. 5 is a section taken at the line 5 on Fig. 4 and viewed in the direction of the arrow; and Fig. 6, a section taken at the line 6 on Fig. 4 and viewed in the direction of the arrow, with certain parts of the operating mechanism broken away to better disclose details.

The floor of an automobile adjacent to the front seat thereof is represented at 10, and the dash-board at 11, the hood for the engine being shown at 12.

The engine in connection with which I have chosen to illustrate my invention is of the 6-cylinder type comprising cylinders 13 to 18 inclusive, which are adapted to receive their impulses in regular succession as is well understood in the art. The stems of the vertically reciprocable exhaust-valves as commonly provided in engines of this class, are represented at 19, and are adapted to be successively operated in a well-known manner from cams 20 arranged in varying positions on a drive-shaft 21, one only of which cams is illustrated. The stems of the inlet-valves of the engine illustrated are represented at 22 and are of the mechanically-operated type, being successively operated by cams (not shown) carried on the shaft 23, the engine as above described being of usual construction and operating in a well known manner under the action of combustible gases introduced into the engine-cylinders.

Located at any convenient point on the car is a tank 24, this tank communicating with a pipe 25 which is coupled at 26 to a pipe 27, the lower end of which terminates in a manifold 28, the upwardly-extending branch-pipes of which are represented at 29. The upper end of the pipe 27 leads into a T-coupler 30 which is connected with a pipe 31 opening at one end into a 3-way valve-controlled pet-cock and primer 32 communicating with the interior of the cylinder 13 above the piston therein (not shown), the connection at the other end of the pipe 31 being hereinafter described.

Secured to one side of the crank-casing 33 of the engine at one side thereof is a bracket-member 34 carrying a plurality of valves 35, one of such valves being positioned directly opposite and to one side of each of the exhaust-valve stems 19. Each of the valves 35 contains a horizontally-disposed conical valve-seat 36 with which a reciprocable conically-headed valve-stem 37 coöperates, these valve-stems being normally held in close engagement with the coöperating seats 36 by means of coiled springs 38 confined between the headed ends of the stems 37 and plugs 39 screwed into the valve-casings. Each of the valves 35 contains a ver-

tically-disposed conduit 40 which extends entirely through it and opens through the valve-seat 36, as illustrated in Fig. 2. The branch-pipes 29 which are of a number corresponding to the number of valves 35, communicate at their upper ends with the lower ends of the conduits 40 of the respective valves, and the upper ends of the conduits 40 of the valves 35 opposite to the cylinders 13 to 17 inclusive communicate with the pipes 41, and the valve 35 opposite the cylinder 18 with the lower end of the pipe 31, the pipes 41 from each of the valves 35 communicating with the interior of the cylinders next in advance thereof as illustrated in the drawings, namely the pipe 41 leading from the valve opposite cylinder 13 communicates with the interior of the cylinder 14, the pipe 41 from the valve 35 opposite cylinder 14 communicates with the interior of the cylinder 15, and so on throughout the series of cylinders, the pipe 31 communicating with the interior of the cylinder 13.

Fulcrumed between its ends at any suitable point on the vehicle is a bell-crank lever 42, the lower short arm of which is pivotally connected with a longitudinally reciprocable bar 43, which has pivotal connection, as indicated at 44, with the upper long arms of a series of bell-crank levers 45 fulcrumed, as indicated at 45^a, to the bracket 34, one opposite each of the six cylinders. The short arms of the bell-cranks 45 are pivotally connected, as through the medium of pins 46 working in slots 47, with the lower extremities 48 of vertically reciprocable blocks 49 supported on the outer ends of the stems 37, one of these blocks being located opposite each of the exhaust-valve stems 19. The members 48 are preferably in the form of a flat spring for a purpose hereinafter understood, and the blocks 49 preferably contain vertically disposed undercut slots 50 which slidably engage with annular flanges 51 on the outer ends of the stems 37, as illustrated in Fig. 5, whereby the blocks 49 are guided when raised and lowered as hereinafter described. One face of each of the blocks 49 is inclined as represented at 52 and oppose blocks 53 rigidly secured to the adjacent exhaust-valve stems 19, as illustrated of one in Figs. 4 and 5. The long arm of the bell-crank 42 is of yoke-shape as indicated at 54 and embraces a vertically reciprocable spring-controlled plunger 55 passing through an opening 56 in the floor 10 of the car, and located preferably at such a point therein as to permit the operator to conveniently depress the same with his foot for a purpose hereinafter described. The plunger 55 carries two stops 57 and 58 arranged respectively above and below the yoke 54 and adapted to alternately engage therewith in the reciprocatory movements of the plunger 55.

The parts of the starting mechanism are normally in the positions illustrated in Fig. 1, namely the plunger 55 is raised, and all of the cam-blocks 49 are elevated on their cooperating stems 37 to a position in which they are out of the path of movement of the blocks 53 during the reciprocating movements of the valve-stems 19.

In the normal operation of the engine, namely while receiving its impulses from the explosion of gases supplied thereto, the tank 24 being in open communication with the cylinder 13, receives spent gases from this cylinder and thus a supply of compressed fluid is maintained in the tank, the coupling 30 being preferably provided with a ball-valve 59 operating to permit the introduction of the spent gases into the tank 24, but prevent their return to this cylinder, and the pipe 25 containing preferably a straight-way valve 60 of ordinary construction carrying a crank-arm 61 having slotted pin connection 62 with the plunger 55, this valve operating, when in normal position, to close the pipe 25, and afford open communication between the tank 24 and cylinder 13 when the lever 61 is depressed by the movement of the plunger 55 downwardly throughout a portion only of its stroke, namely before the member 57 is carried to a position in which it rocks the lever 42; and to maintain such open communication between the tank 24 and the header 28 when the plunger 55 is depressed sufficiently far to rock the lever 42 downwardly at its long arm. The connection between the tank 24 and cylinder 13 is thereby rendered normally closed, but may be opened by the operator at will to supply gas to the tank 24, a gage 63 connected with the pipe 25 by a pipe 64 being provided for registering the pressure in the tank 24. When the engine comes to rest after the supply of combustible gas thereto is shut off, at least one of its exhaust-valves will be open, and thus at least one of the rods 19 will be in raised position as represented of the exhaust-valve of cylinder 13. To start the engine, the operator depresses the plunger 55 sufficiently far to cause the member 57 to rock the bell-crank 42 downwardly at its long arm, thereby shifting the bar 43 to the right in Fig. 1, with the result of turning all of the bell-cranks 45 on their fulcrums 46 and drawing the short arms of these levers downwardly. Thus operating the levers 45 depresses all of the cam-blocks 49 and carries them into the path of upward movement of the adjacent blocks 53. As one of the exhaust valves is open, as before stated, when the engine is at rest, the cam-block 49 opposite this valve will, in the operation of shifting the rod 43 to the right in Fig. 1 as described, ride upon the adjacent block and force its coöperating valve 35 open, thus permitting fluid-pressure to flow

from the tank 24 and header 28 through the adjacent one of the pipes 29 and communicating pipe 41 into the cylinder in advance of it, the piston of which is in position to receive the impulse produced by the admission of the compressed fluid-pressure into the cylinder, and the engine will thereupon begin to operate. Thus when the parts of the engine when at rest assume the positions illustrated in Fig. 1, the exhaust-valve of cylinder 13 is open and consequently the block 53 is raised, whereby the first impulse will be communicated to the cylinder 14 by the opening of the valve 35 opposite cylinder 13. As the stem 19 of the exhaust-valve of cylinder 14 rises, it operates to open the valve 35 opposite this cylinder and admit fluid-pressure into the cylinder 15, and so on throughout the series of cylinders as the crank-shaft continues to rotate. It will thus be seen that so long as the operator holds the plunger 55 depressed, fluid-pressure will flow from the tank 24 into the cylinders in succession and the engine may be given the desired number of revolutions to effect its initial starting.

It will be manifest from the foregoing description that when the parts of the starting mechanism are in normal inoperative position, none of the parts thereof is subjected to wear by engagement with any of the parts of the engine which operate when the latter is operating normally, and thus wear of parts is reduced to the minimum. Furthermore, it will be noted that the starting mechanism is of such a character that it may be readily applied to an existing engine without the necessity of remodeling or reconstructing the same.

The 3-way valves interposed in the pipes 31 and 41 are provided for the purpose of permitting the cylinders to be primed independently of each other as desired, and when operated to cause the surmounting cups to be open to the interior of the cylinders to close the pipes 41, it being understood that when the cups referred to are closed to the cylinders open communication between the pipes 41 and the interiors of the respective cylinders is maintained.

While I have illustrated my starter mechanism as operated from the exhaust-valves of the engine, I do not wish to be understood as intending to be limited to its operation in this manner, as it may be equally well operated from other fluid-pressure-controlling valves of the engine, viz. the inlet-valves, when the latter are mechanically operated. Furthermore, while I have illustrated and described my invention as applied to a 6-cylinder engine, it is not limited in its use thereto, as it may be readily incorporated in an engine of any number of cylinders, either more or less than that illustrated, provided, in so far as the main feature of my invention is concerned, any one or more of either of its mechanically-operated inlet or exhaust-valves are in open position when the engine comes to rest.

The engine illustrated is of the type in which the pistons in the cylinders receive their impulses in regular succession, viz., the piston of cylinder 14 is the next to operate after the piston in cylinder 13, the piston in cylinder 15 is then next to operate, and so on throughout the series of cylinders. I do not wish to be understood, however, as intending by such description and illustration to limit my invention to use in connection with an engine thus operating in regular succession, as it may be equally well applied to engines in which the pistons in adjacent cylinders operate in any other order than that described, in which case the connections with the cylinders of the fluid-pressure conducting pipes leading from the valves 35 would be altered accordingly, as will be manifest. Furthermore, while I have shown my invention as embodied in an engine, in which each cylinder thereof is adapted to be supplied with fluid-pressure for starting the engine, I do not wish to be understood as intending to limit my invention to an engine in which each of the cylinders thereof is supplied with fluid-pressure for the starting purpose, as less than the whole number of the cylinders of a multiple-cylinder engine may be so supplied without departing from the spirit of my invention.

While I have illustrated and described a certain particular embodiment of my invention, I do not wish to be understood as intending to limit it to such embodiment, as the construction shown may be variously modified without departing from the spirit of my invention.

What I claim as new, and desire to secure by Letters Patent, is—

1. The combination with a multiple-cylinder internal combustion engine, of engine-starting mechanism therefor comprising a supply of compressed fluid-pressure, normally closed valve-mechanism for controlling the flow of fluid from said supply to the cylinders of the engine, and means operated by mechanically-actuated fluid-pressure-controlling valves of the engine for opening said first-named valve-mechanism, for the purpose set forth.

2. The combination with a multiple-cylinder internal combustion engine, of engine-starting mechanism therefor comprising a supply of compressed fluid-pressure, valve-mechanism for controlling the flow of fluid from said supply to the cylinders of the engine, means operated by mechanically-actuated fluid-pressure-controlling valves of the engine for operating said first-named valve-mechanism, and mechanical means for con-

trolling the actuation of said first-named means for starting and stopping the engine-starting mechanism.

3. The combination with a multiple-cylinder internal combustion engine, of engine-starting mechanism therefor comprising a supply of compressed fluid-pressure, valve-mechanism for controlling the flow of fluid from said supply to the cylinders of the engine, means operated by mechanically-actuated fluid-pressure-controlling valves of the engine for operating said first-named valve-mechanism, and means for controlling the actuation of said first-named means for starting and stopping the engine-starting mechanism, the parts of said engine-starting mechanism, when in normal, inoperative position, being out of engagement with the working parts of the engine, for the purpose set forth.

4. The combination with a multiple-cylinder internal combustion engine, of engine-starting mechanism therefor comprising a supply of compressed fluid-pressure, a plurality of valves for controlling the flow of fluid from said supply to the cylinders of the engine, and devices interposed between said valves and mechanically-actuated fluid-pressure-controlling valves of the engine and adjustable with relation to said valves, operating when in a certain position to control the actuation of said first-named valves by the movement of said engine-valves, for the purpose set forth.

5. The combination with a multiple-cylinder internal combustion engine, of engine-starting mechanism therefor, comprising a supply of compressed fluid-pressure, a plurality of reciprocatory valves for controlling the flow of fluid from said supply to the cylinders of the engine, and devices interposed between said valves and mechanically-actuated fluid-pressure-controlling valves of the engine and adjustable with relation to said valves, operating when in a certain position to control the actuation of said first-named valves by the movement of said engine-valves, for the purpose set forth.

6. The combination with a multiple-cylinder internal combustion engine, of engine-starting mechanism therefor comprising a supply of compressed fluid-pressure, a plurality of valves for controlling the flow of fluid from said supply to the cylinders of the engine, devices coöperating with said valves and adjustable with relation thereto, and means actuated by mechanically-actuated fluid-pressure-controlling valves of the engine adapted to engage with said adjustable devices when the latter are in a certain position to control the actuation of said first-named valves, for the purpose set forth.

7. The combination with a multiple-cylinder internal combustion engine, of engine-starting mechanism therefor comprising a supply of compressed fluid-pressure, a plurality of normally closed reciprocatory valves for controlling the flow of fluid from said supply to the cylinders of the engine, and means operated by mechanically-operated fluid-pressure-controlling valves of the engine for moving said first-named valves to open position, for the purpose set forth.

8. The combination with a multiple-cylinder internal combustion engine, of engine-starting mechanism therefor comprising a supply of compressed fluid-pressure, a plurality of reciprocatory valves for controlling the flow of fluid from said supply to the cylinders of the engine, devices coöperating with said valves and adjustable with relation thereto, and means actuated by mechanically-operated valves of the engine adapted to engage with said adjustable devices when the latter are in a certain position for opening said first-named valves, for the purpose set forth.

9. The combination with a multiple-cylinder internal combustion engine, of engine-starting mechanism therefor comprising a supply of compressed fluid-pressure, a plurality of valves for controlling the flow of fluid from said supply to the cylinders of the engine, and cam-mechanism operated by mechanically-actuated fluid-pressure-controlling valves of the engine for operating said first-named valves, for the purpose set forth.

10. The combination with a multiple-cylinder internal combustion engine, of engine-starting mechanism therefor comprising a supply of compressed fluid-pressure, a plurality of valves for controlling the flow of fluid from said supply to the cylinders of the engine, and adjustable cam-mechanism operated by mechanically-operated fluid-pressure-controlling valves of the engine for operating said first-named valves, for the purpose set forth.

11. The combination with a multiple-cylinder internal combustion engine, of engine-starting mechanism therefor comprising a supply of compressed fluid-pressure, a plurality of reciprocatory valves for controlling the flow of fluid from said supply to the cylinders of the engine, and cam-mechanism operated by mechanically-actuated fluid-pressure-controlling valves of the engine for operating said first-named valves, for the purpose set forth.

12. The combination with a multiple-cylinder internal combustion engine, of engine-starting mechanism therefor comprising a supply of compressed fluid-pressure, a plurality of reciprocatory valves for controlling the flow of fluid from said supply to the cylinders of the engine, adjustable cam-mechanism coöperating with said valves, and means actuated by mechanically-operated fluid-pressure-controlling valves of the

engine adapted to engage with said adjustable devices when the latter are in a certain position for opening said first-named valves for the purpose set forth.

13. The combination with multiple-cylinder internal combustion engine, of engine-starting mechanism therefor comprising a supply of compressed fluid-pressure, a plurality of valves for controlling the flow of fluid from said supply to the cylinders of the engine, and cam-mechanism carried by the stems of said valves and operated by mechanically-actuated fluid-pressure-controlling valves of the engine for operating said first-named valves, for the purpose set forth.

14. The combination with a multiple-cylinder internal combustion engine, of engine-starting mechanism therefor comprising a supply of compressed fluid-pressure, a plurality of valves for controlling the flow of fluid from said supply to the cylinders of the engine, and adjustable cam-mechanism carried by the stems of said valves and operated by mechanically-actuated fluid-pressure-controlling valves of the engine for operating said first-named valves, for the purpose set forth.

15. The combination with a multiple-cylinder internal combustion engine, of engine-starting mechanism therefor comprising a supply of compressed fluid-pressure, a plurality of reciprocatory valves for controlling the flow of fluid from said supply to the cylinders of the engine, and cam mechanism operated by mechanically-actuated fluid-pressure-controlling valves of the engine for operating said first-named valves, for the purpose set forth.

16. The combination with a multiple-cylinder internal combustion engine, of engine-starting mechanism therefor comprising a supply of compressed fluid-pressure, a plurality of reciprocatory valves for controlling the flow of fluid from said supply to the cylinders of the engine, adjustable cam-devices carried by the stems of said valves and coöperating with the latter, and means actuated by mechanically-operated fluid-pressure-controlling valves of the engine adapted to engage with said adjustable devices when the latter are in a certain position for opening said first-named valves, for the purpose set forth.

17. The combination with a multiple-cylinder internal combustion engine, of engine-starting mechanism therefor comprising a supply of compressed fluid-pressure, a plurality of valves for controlling the flow of fluid from said supply to the cylinders of the engine, and shiftable devices reciprocably mounted on the stems of said valves and adapted when shifted into a certain position to be operated by mechanically-actuated fluid-pressure-controlling valves of the engine for opening the valves carrying them, for the purpose set forth.

18. The combination with a multiple-cylinder internal combustion engine, of engine-starting mechanism therefor comprising a supply of compressed fluid-pressure, a plurality of reciprocatory valves for controlling the flow of fluid from said supply to the cylinders of the engine, and shiftable devices reciprocatorily mounted on the stems of said valves and adapted, when shifted into a certain position, to be operated by mechanically-actuated fluid-pressure-controlling valves of the engine for opening the valves carrying them, for the purpose set forth.

19. The combination with a multiple-cylinder internal combustion engine, of engine-starting mechanism therefor comprising a supply of compressed fluid-pressure, valve-mechanism for controlling the flow of fluid from said supply to the cylinders of the engine, means operated by mechanically-actuated fluid pressure-controlling valves of the engine for operating said first-named valve-mechanism, and lever-mechanism for controlling the actuation of said first-named means for starting and stopping the engine-starting mechanism.

20. The combination with a multiple-cylinder internal combustion engine, of engine-starting mechanism therefor comprising a supply of compressed fluid-pressure, a plurality of valves for controlling the flow of fluid from said supply to the cylinders of the engine, adjustable devices interposed between said valves and mechanically-actuated fluid-pressure-controlling valves of the engine, operating when in a certain position to control the actuation of said first-named valves by the movement of said engine-valves, and means for adjusting said devices comprising a series of levers connected together and operating, when actuated, to adjust said devices.

21. The combination with a multiple-cylinder internal combustion engine, of engine-starting mechanism therefor comprising a supply of compressed fluid-pressure, a plurality of valves for controlling the flow of fluid from said supply to the cylinders of the engine, adjustable devices interposed between said valves and mechanically-actuated fluid-pressure-controlling valves of the engine, operating when in a certain position to control the actuation of said first-named valves by the movement of said engine-valves, and means for adjusting said devices comprising a longitudinally shiftable member and a series of levers connected therewith and operating, when actuated, to adjust said devices.

22. The combination with a multiple-cylinder internal combustion engine, of engine-starting mechanism therefor comprising a supply of compressed fluid-pressure, a plu-

rality of valves for controlling the flow of fluid from said supply to the cylinders of the engine, adjustable devices interposed between said valves and mechanically-actuated fluid-pressure-controlling valves of the engine, operating when in a certain position to control the actuation of said first-named valves by the movement of said engine-valves, and means for adjusting said devices comprising a longitudinally shiftable member, and a series of bell-crank levers connected therewith and operating, when actuated, to adjust said devices.

23. The combination with a multiple-cylinder internal-combustion engine, of engine-starting mechanism therefor comprising a supply of compressed fluid-pressure, a plurality of valves for controlling the flow of fluid from said supply to the cylinders of the engine, reciprocatory devices interposed between said valves and mechanically-actuated fluid-pressure-controlling valves of the engine operating, when in a certain position, to control the actuation of said first-named valves by movement of said engine-valves, and means for shifting said devices comprising a series of levers connected together and operating, when actuated, to shift said devices.

24. The combination with a multiple-cylinder internal combustion engine having mechanically-operated fluid-pressure-controlling valves formed with offset portions, of engine-starting mechanism therefor comprising a supply of fluid-pressure, a plurality of valves for controlling the flow of fluid from said supply to the cylinders of the engine, and means interposed between said last referred to valves and said offset-portions and actuated through the medium of the latter by the movement of said first referred to valves for operating said engine-starter valves, for the purpose set forth.

25. The combination with a multiple-cylinder internal combustion engine having mechanically-operated fluid-pressure-controlling valves formed with offset portions, of engine-starting mechanism therefor comprising a supply of fluid-pressure, a plurality of valves for controlling the flow of fluid from said supply to the cylinders of the engine, and adjustable devices interposed between said last referred to valves and said offset-portions and adapted when occupying a certain position to be actuated through the medium of the offset-portions of said valves by the movement of said first referred to valves for operating said engine-starter valves, for the purpose set forth.

HERBERT M. HALLSWORTH.

In presence of—
R. A. SCHAEFER,
JOHN WILSON.