Nov. 17, 1959 L. D. GILMORE ET AL 2,912,967

STARTING APPARATUS FOR INTERNAL COMBUSTION ENGINES

Filed March 28, 1958 6 Sheets-Sheet 1

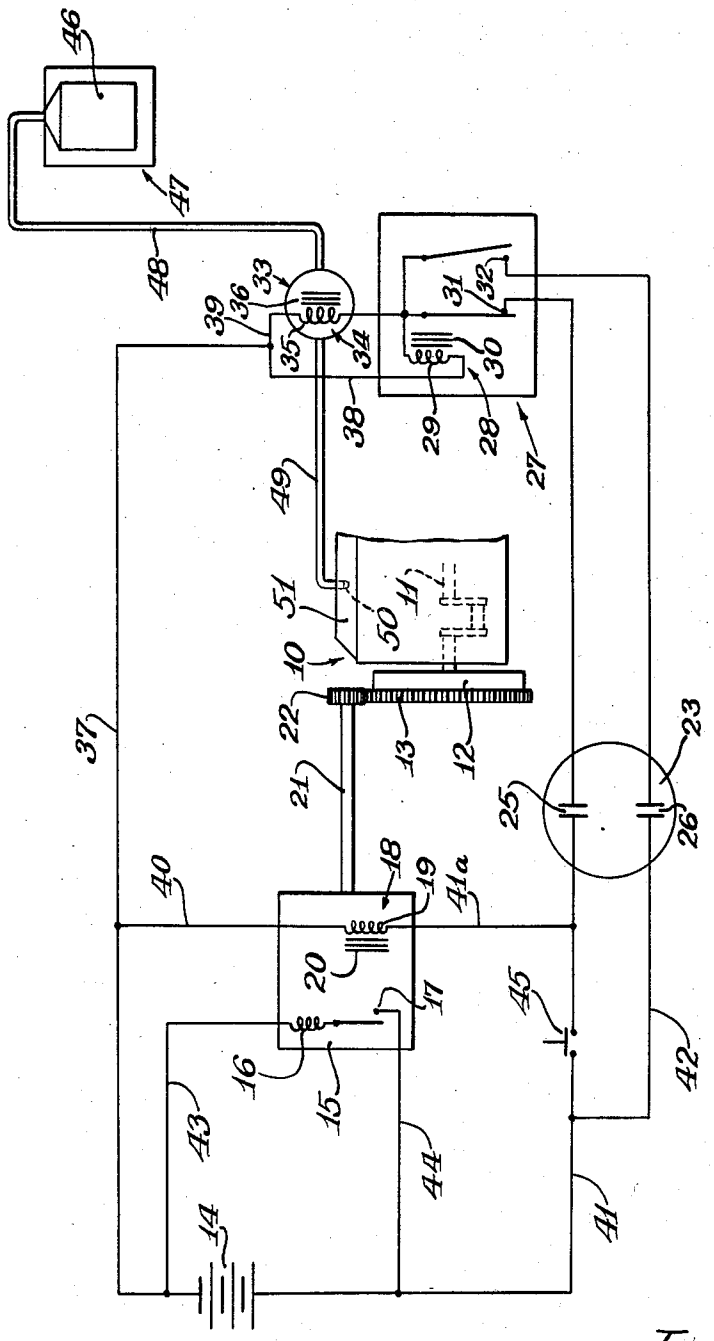


FIG. 1.

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STARTING APPARATUS FOR INTERNAL COMBUSTION ENGINES

Filed March 28, 1958 6 Sheets-Sheet 2

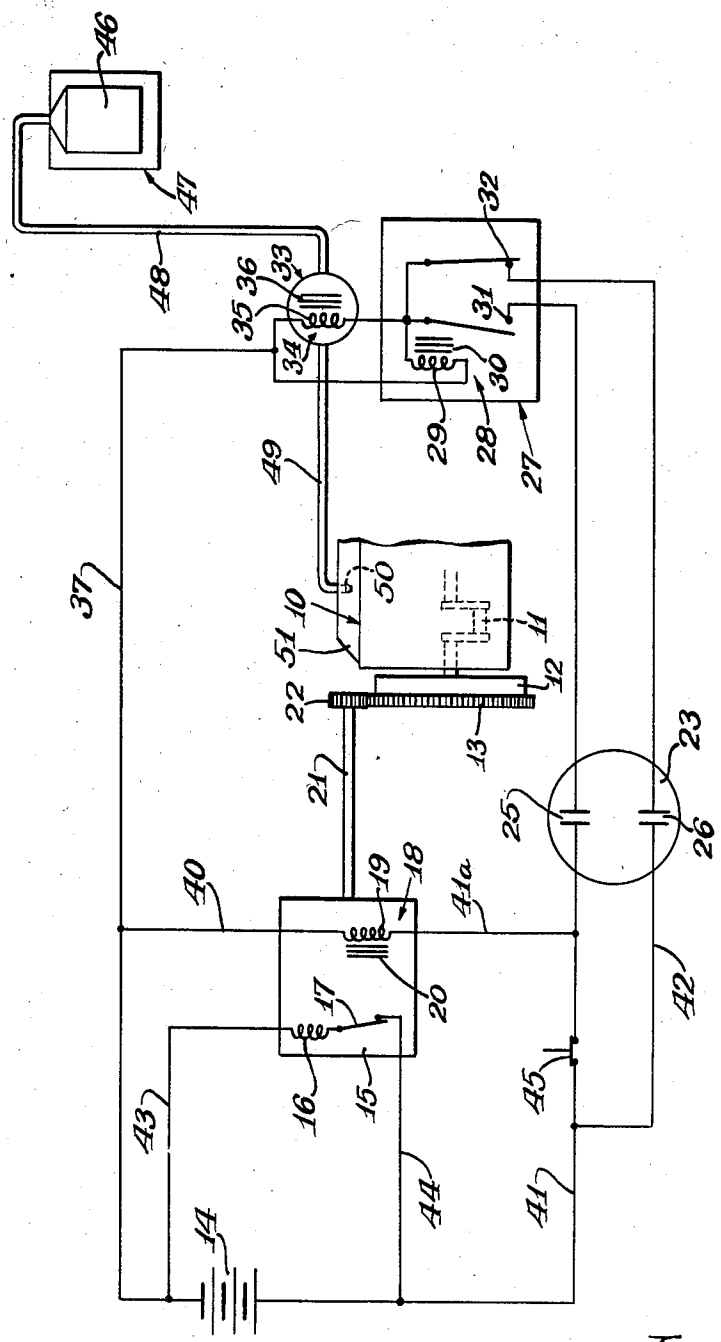


FIG. 2.

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STARTING APPARATUS FOR INTERNAL COMBUSTION ENGINES

Filed March 28, 1958 6 Sheets-Sheet 3

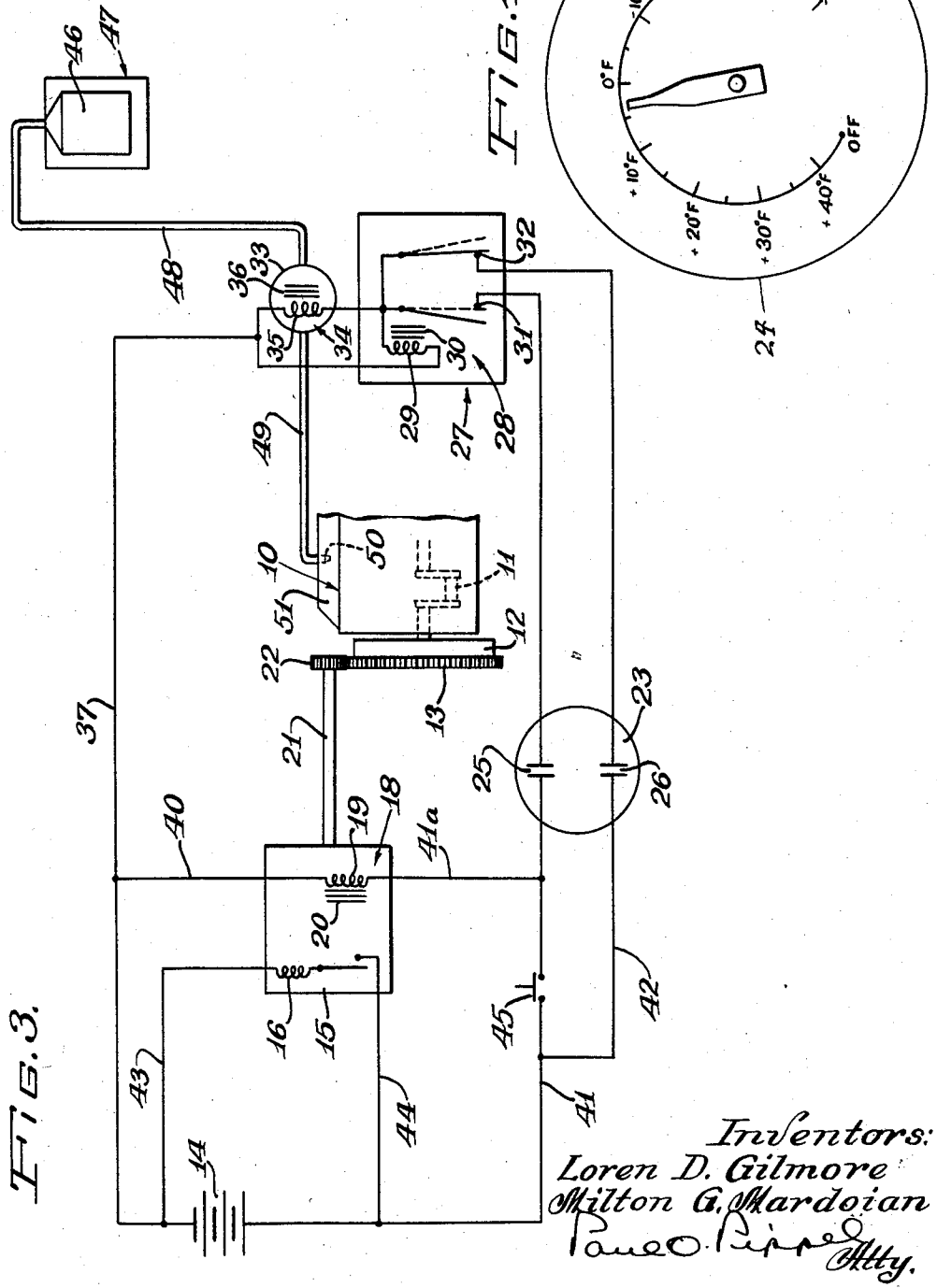


FIG. 3.

FIG. 4.

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Nov. 17, 1959 L. D. GILMORE ET AL 2,912,967

STARTING APPARATUS FOR INTERNAL COMBUSTION ENGINES

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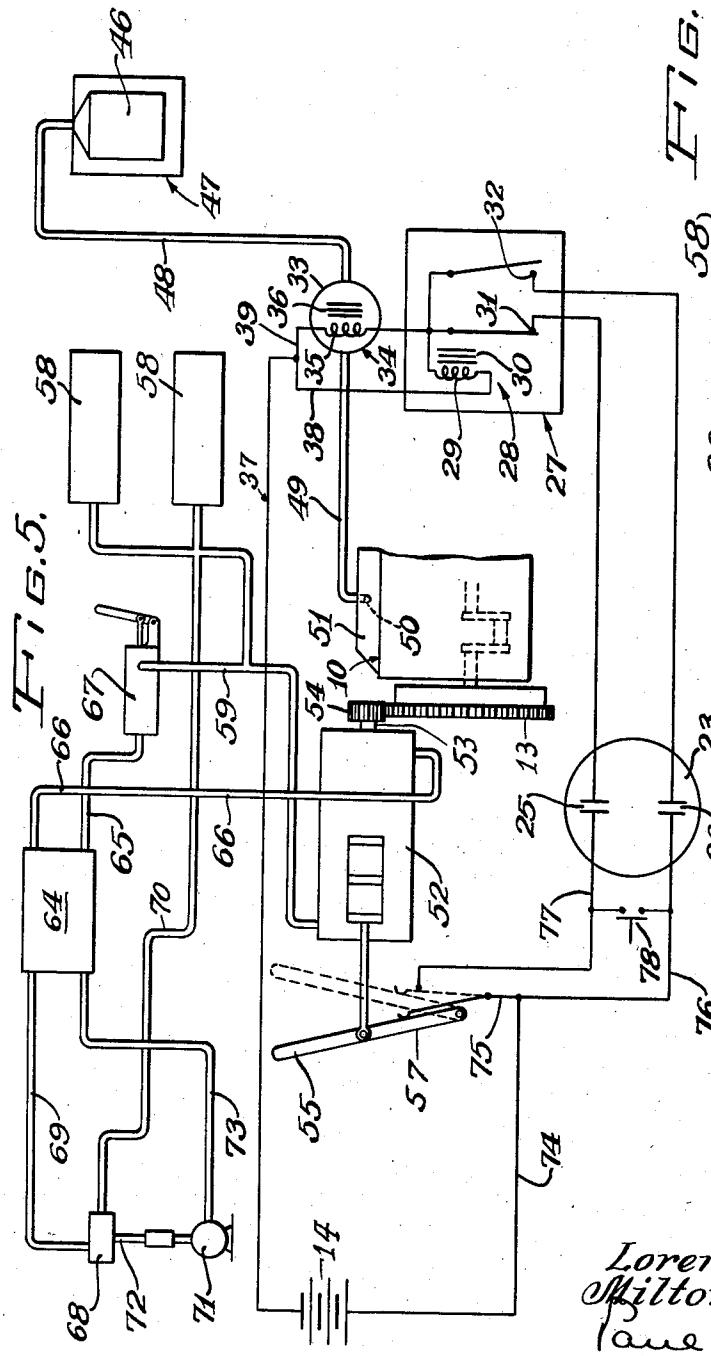


FIG. 5.

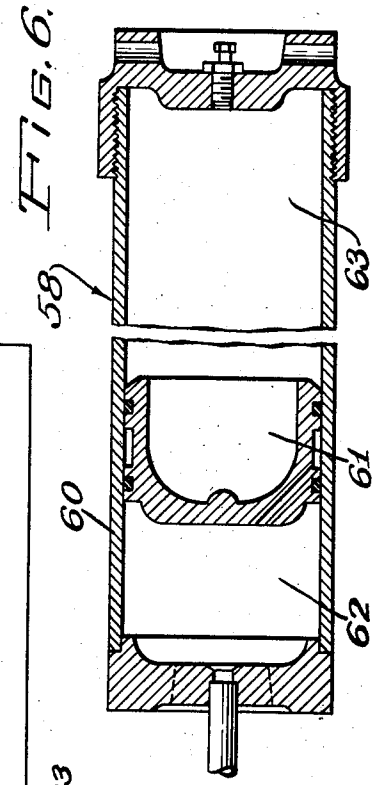


FIG. 6.

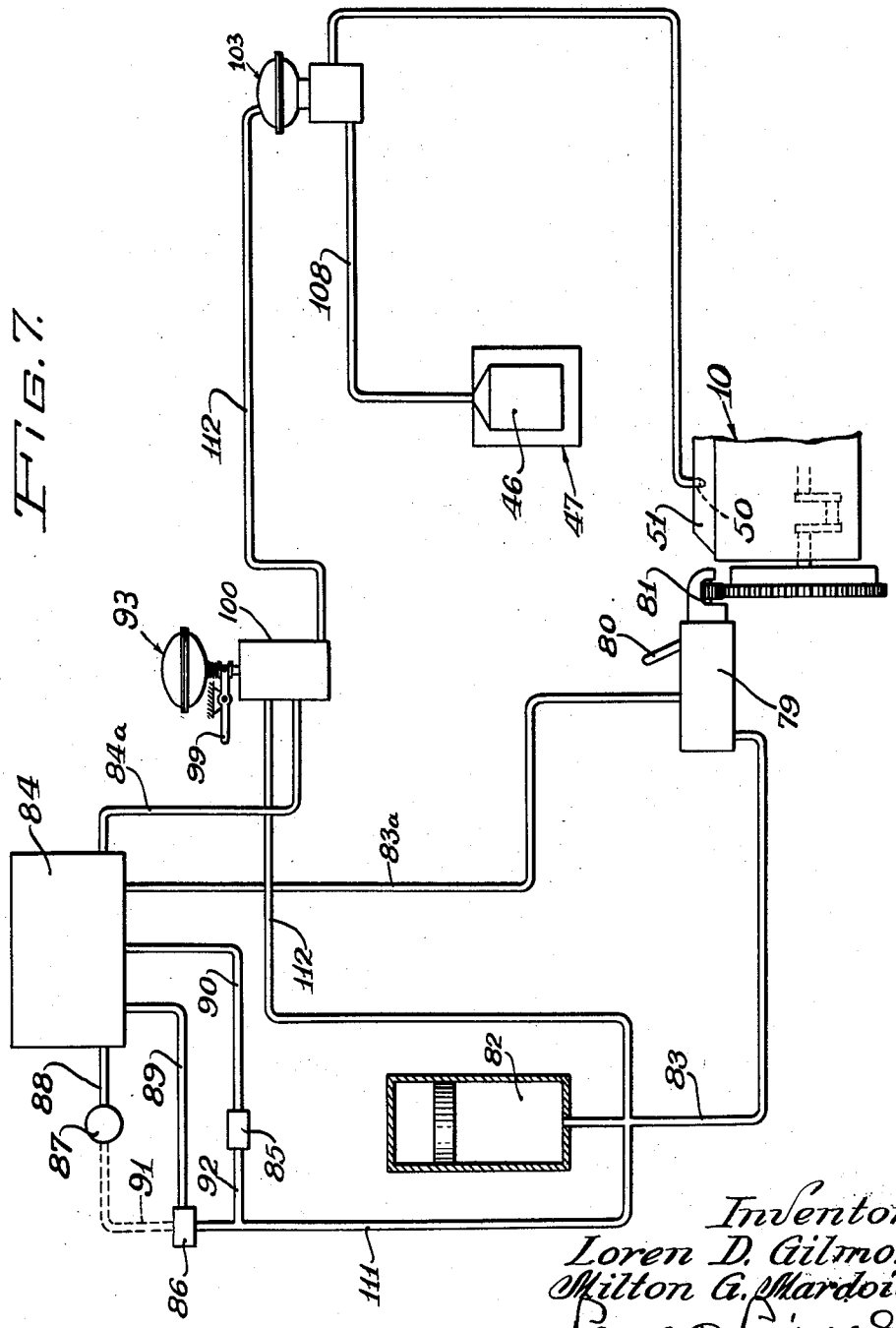
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STARTING APPARATUS FOR INTERNAL COMBUSTION ENGINES

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FIG. 7.



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Nov. 17, 1959 L. D. GILMORE ET AL 2,912,967

STARTING APPARATUS FOR INTERNAL COMBUSTION ENGINES

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FIG. 8.

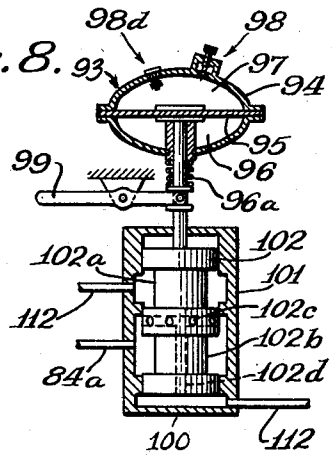


FIG. 11.

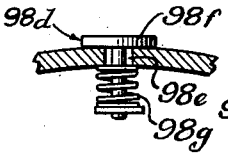


FIG. 10.

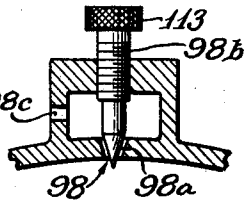


FIG. 13.

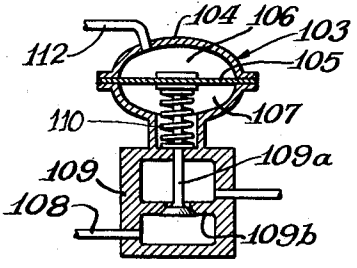


FIG. 9.

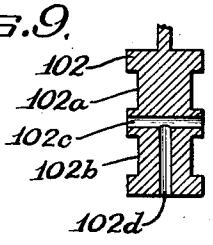
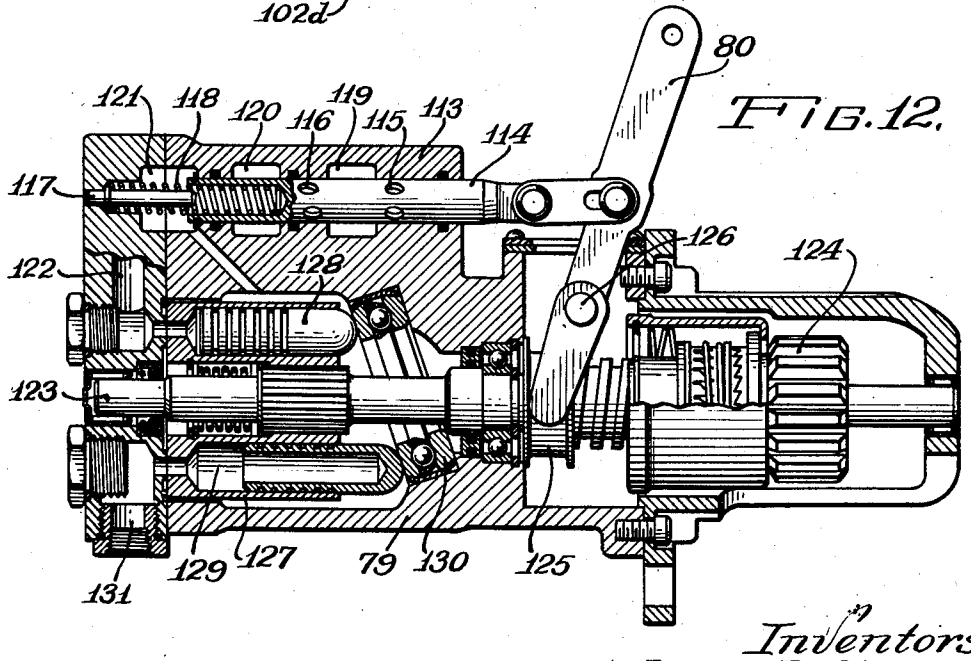


FIG. 12.



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United States Patent Office 2,912,967
Patented Nov. 17, 1959

2,912,967

STARTING APPARATUS FOR INTERNAL COMBUSTION ENGINES

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Application March 28, 1958, Serial No. 724,553

7 Claims. (Cl. 123—179)

This invention relates to starting apparatus for internal combustion engines.

An object of the invention is to provide starting apparatus for internal combustion engines wherein every part of the apparatus is preset before the beginning of the starting operation.

Another object of the invention is to provide starting apparatus for internal combustion engines wherein a minimum amount of starting fluid is used for starting the engine.

Another object of the invention is to provide starting apparatus for internal combustion engines wherein starting fluid cannot be misused thus preventing engine damage.

A further object of the invention is to provide starting apparatus for internal combustion engines arranged to allow remote operation.

A still further object of the invention is to provide starting apparatus for internal combustion engines having simplicity of operation.

The foregoing and other objects of the invention will be apparent from the construction and arrangement illustrated in the accompanying drawings wherein:

Figure 1 is a schematic view of one form of the invention showing it before the starting operation is begun,

Figure 2 is a schematic view of the starting apparatus of Figure 1 showing it after pressing the cranking motor push button,

Figure 3 is a schematic view of the starting apparatus of Figure 1 showing it after releasing the cranking motor push button,

Figure 4 is an elevational view of the timer,

Figure 5 is a schematic view of a second form of starting apparatus,

Figure 6 is a longitudinal sectional view through one of the accumulators shown in Figure 5,

Figure 7 is a schematic view of a third form of starting apparatus,

Figure 8 is a sectional view of a two-way valve and timer shown in Figure 7,

Figure 9 is a longitudinal sectional view of the plunger of the two-way valve shown in Figure 8,

Figure 10 is a sectional view of the adjustable orifice on the timer shown in Figure 8,

Figure 11 is a sectional view through the poppet valve on the timer shown in Figure 8,

Figure 12 is a longitudinal sectional view of the hydraulic cranking motor shown in Figure 7, and

Figure 13 is a sectional view of the starting fluid release means.

In the past a number of ways have been used to start internal combustion engines. One way is to discharge an ether capsule into the intake manifold of the engine. The disadvantage of this way is to use one capsule and if the engine fails to start use another capsule for the next starting attempt and so on. The capsules are costly and too much ether in the intake manifold will cause severe detonation and excessive cylinder wall wear. Another way of starting an internal combustion engine is to put ether liquid in a container and then put the ether under pressure by means of a hand pump. A manually operated valve on the container is opened to let ether flow into the intake manifold of the engine. The disadvantages of this way are that the operator is exposed to fumes and a fire hazard is created and this way is also costly. Another way of starting an internal combustion engine is to take a container of ether under pressure and spray the ether into the air cleaner of the engine. The disadvantages of this way are that a fire hazard is created and the engine will not start at low temperatures and the employment of this way is a two-man operation. Another way of starting an internal combustion engine is to use a capsule containing ether not under pressure. A casing is provided and has a puncture needle to puncture the capsule and then a plunger is used to build up pressure in the casing and a mixture of air and ether flow out of the casing into the intake manifold of the engine. The disadvantages of this way are very poor starting characteristics at moderate temperatures and at low temperatures the engine won't start and one is limited in the amount of priming fluid that can be used for attempting to start the engine once. One capsule is used for each engine starting attempt. It is necessary to syphon the ether out of the casing after the engine is running. If the nozzle in the intake manifold is lower than the casing ether will flow by gravity into the intake manifold causing severe detonation when starting the engine and the passage from the casing to the nozzle clogs up at low temperatures.

The invention proposes an apparatus for starting an internal combustion engine. The invention is comprised of a cranking motor having a shaft operatively connected to the engine crankshaft and a power means in communication with the cranking motor is provided for driving the shaft. A container containing starting fluid under pressure is provided and a valve is in communication with the container and is also in communication with the intake manifold of the internal combustion engine and a timer is in communication with the valve. The cranking motor and timer are started at approximately the same time to cause cranking of the internal combustion engine and opening of the valve to let starting fluid flow to the intake manifold of the internal combustion engine and upon stopping of the cranking motor flow of starting fluid to the intake manifold is continued until the timer shuts off. This invention has the advantages that the starting apparatus is preset before beginning the starting operation and a minimum amount of starting fluid is used for starting the engine and the starting apparatus prevents misuse of ether so as to avoid engine damage and remote operation is provided and the starting apparatus has simplicity of operation.

In the drawings, 10 generally designates an internal combustion engine in the form of a diesel engine having a crankshaft 11 and a flywheel 12 and a spur gear 13 fixedly secured to the flywheel. The apparatus for starting the diesel enigne 10 is comprised of a battery 14 and a cranking motor 15. The cranking motor 15 is comprised of an armature winding 16 and a contact 17 and a solenoid 18 having a solenoid coil 19 and a core 20 and a shaft 21 and a spur gear 22 fixedly secured on the outer end of the shaft and meshing with the spur gear 13 on the flywheel 12. A timer 23 has a dial 24 graduated in degrees Fahrenheit temperature and has a pair of contacts 25 and 26. A relay 27 is comprised of a solenoid 28 having a solenoid coil 29 and a core 30 and a pair of contacts 31 and 32 which are opened and closed by the solenoid. A valve 33 has a solenoid 34 including a solenoid coil 35 and a core 36. A wire 37 leads from the battery 14 and has a pair of branch wires 38 and 39

with the wire 38 leading to the solenoid coil 29 of the relay 27 and the wire 39 leading to the solenoid coil 35 of the valve 33. A wire 40 leads from wire 37 to the solenoid coil 19 of the cranking motor 15. A wire 41 leads from the battery 14 through the contact 25 of the timer 23 to the contact 31 in the relay 27 and a wire 42 leads from wire 41 through contact 26 in the timer to the contact 32 in the relay. A wire 41*a* leads from the solenoid coil 19 to the wire 41. A wire 43 leads from wire 37 to the armature winding 16 in the cranking motor 15 and a wire 44 leads from wire 41 to the contact 17 in the cranking motor. A cranking motor starter button or starter switch 45 is disposed in wire 41. A container 46 containing a starting fluid under pressure such as ether is provided and a holding means 47 is mounted on the diesel engine 10 to hold the container. A conduit 48 leads from the container 46 to the valve 33 and the container valve is opened when the container is positioned in the holding means 47 so that ether fills the conduit. A conduit 49 leads from the valve 33 and has a nozzle 50 thereon which is disposed in the intake manifold 51 of the diesel engine. The combination of the solenoid coils 29 and 35, cores 30 and 36, and contacts 31 and 32 act as a holding system or delay circuit for the valve 33.

The operation of the form of the invention shown in Figures 1 to 4 inclusive is as follows: First, the timer 23 is set to atmospheric temperature which closes the contacts 25 and 26 in the timer. Second, the cranking motor push button 45 is pressed which energizes the solenoid 18 in the cranking motor 15 to close the contact 17 in the cranking motor resulting in starting of the cranking motor to crank the diesel engine 10. Before pressing the cranking motor push button or starter mechanism 45 relay contact 31 is closed and relay contact 32 is open. After pressing the cranking motor push button 45 relay contact 31 is opened and relay contact 32 is closed. The solenoid 34 on the valve 33 opens the valve so that ether is injected through nozzle 50 into the intake manifold 51 of the diesel engine 10. The circuit completion through relay 27, causes contact 31 to be opened and contact 32 to be closed thus maintains energization to valve 34 through contact 26 and contact 32. The cranking motor push button 45 is held depressed until the diesel engine 10 is firing on a majority of its cylinders. Third, upon releasing the cranking motor push button 45 the cranking motor 15 is shut off and ether continues to be injected until the temperature pointer on the timer 23 returns to its original position whereupon the circuit is broken through contact 26 in the timer through opening of this contact and relay contacts 31 and 32 are returned to their original position.

The second form of the invention is shown in Figure 5. This form of the invention is comprised of a hydraulic cranking motor 52 having a shaft 53 and a spur gear 54 fixedly secured on the shaft and meshing with the spur gear 13 on the flywheel 12 of the diesel engine 10. The hydraulic cranking motor 52 has a handle 55 adapted to open a valve and a starter switch or mechanism 57 is mounted on the hydraulic cranking motor and is closed when the handle is moved in the direction to open the valve. A pair of accumulators 58 are provided and are in communication with hydraulic cranking motor 52 through conduit means 59. Each accumulator 58 is comprised of a container 60 and a free piston 61 in the container dividing the container into chambers 62 and 63 with oil under pressure being in chamber 62 and nitrogen gas under pressure being in chamber 63. An oil reservoir 64 is provided and is in communication with the hydraulic cranking motor 52 through conduit means 65, 59 and 66. A hand pump 67 is disposed in the conduit means 65 and an unloading valve 68 is provided and conduit 69 leads from the unloading valve to the oil reservoir 64 and a conduit 70 leads from the unloading valve to the accumulators 58. A pump 71 driven by the diesel engine 10 is provided and a conduit 72 leads from the pump to the unloading valve and a conduit 73 leads from the pump to the oil reservoir 64. This form of the invention also has the battery 14 and timer 23 and relay 27 and valve 33 and wire 37 with its branch wires 38 and 39. A wire 74 leads from the battery 14 and a wire 75 leads from the switch 57 to wire 74 and a wire 76 is connected to wires 74 and 75 and goes through the contact 26 in the timer 23 to the relay contact 32. A wire 77 leads from the switch 57 and goes through the contact 25 in the timer 23 to the relay contact 31. A switch 78 is disposed between wires 76 and 77. The switch 78 is a pre-cranking prime switch to inject ether before starting to crank the engine. The operation of this form of the invention is as follows: First the timer 23 is set to atmospheric temperature which closes contacts 25 and 26 in the timer. Second, the switch 78 is closed and solenoid 29 in relay 27 opens contact 31 and closes contact 32 and solenoid 34 opens valve 33 so that ether is injected into the intake manifold 51 of the engine. Third, the switch 78 is opened and after the temperature pointer on the timer 23 returns to its original position the relay contact 31 is closed and relay contact 32 is opened and solenoid 34 closes the valve 33. Fourth, the timer 23 is again set to atmospheric temperature which closes the contacts 25 and 26 in the timer. Fifth, the handle 55 on the hydraulic cranking motor 52 is moved to open the valve so that oil flows from the accumulators 58 through the hydraulic cranking motor to crank the diesel engine 10. This movement of the handle 55 also closes the switch 57 so that solenoid 28 opens relay contact 31 and closes relay contact 32 and solenoid 34 opens valve 33 so that ether is injected into the intake manifold of the engine. After the accumulators 58 are discharged and cranking of the engine is stopped the handle 55 is released. Ether continues to be injected into the intake manifold of the diesel engine until the temperature pointer on the timer returns to its original position whereupon the circuit is broken through contact 26 in the timer through opening of this contact and relay contact 31 is closed and relay contact 32 is opened and valve 33 is closed.

The third form of the invention is shown in Figure 7. A hydraulic cranking motor 79 has a handle 80 acting as a starter switch or mechanism to open a valve in the hydraulic cranking motor so that the shaft 81 which is geared to the flywheel of the engine may be turned by oil flowing from the accumulator 82 through conduit 83. An oil reservoir 84 and a hand pump 85 and an unloading valve 86 and a pump 87 driven by the engine 10 are connected together by conduits 88, 89, 90, 91 and 92. A conduit 83*a* leads from the hydraulic cranking motor 79 to the oil reservoir 84. A timer 93 is comprised of a container 94 and a diaphragm 95 disposed in the container and fixed thereto to divide the container into chambers 96 and 97. The chamber 97 of the container 94 has an adjustable orifice 98 having a temperature dial. The adjustable orifice 98 is made up of a tapered hole 98*a* and a tapered needle 98*b* threaded into an integral mounting portion on the container 94 and a hole 98*c* in the mounting portion. A poppet valve 98*d* is made up of a hole 98*e* in the container 94 and a valve plunger 98*f* and a coil spring 98*g* urging the valve closed. The timer 93 has a handle 99 fixedly secured to the diaphragm 95. A two-way valve 100 is comprised of a housing 101 and a valve plunger 102. The valve plunger 102 is connected to the handle 99 on the timer 93. The valve plunger 102 has grooves 102*a* and 102*b* in its periphery and has a plurality of holes 102*c* spaced around the periphery and a hole 102*d* in communication with holes 102*c*. A conduit 84*a* leads from the oil reservoir 84 to the valve housing 101. A starting fluid release means 103 is comprised of a container 104 and a diaphragm 105 fixedly secured to the container dividing the container into chambers 106 and 107. A conduit 108 leads from the container 46 through the fluid release

means 103, to the intake manifold of the internal combustion engine 10. A valve 109 is disposed in the conduit 108 and has a valve plunger 109*a* fixedly secured to the diaphragm 105 of the starting fluid return means and a valve seat 109*b*. A coil spring 110 is disposed on the valve plunger and urges the valve to closed position. A conduit 111 leads from the unloading valve 86 and conduit 92 from the hand pump 85 to the accumulator 82 and a conduit 112 leads from the accumulator 82 in and out of the interior of the valve housing 101 to the chamber 106 in starting fluid release means 103. The two-way valve 100 and the starting fluid release means 103 act as a holding system for the valve 33. The hydraulic cranking motor 79 shown in Figure 12 is identical to the hydraulic cranking motor shown in Figure 5 except that the switch is omitted. The accumulator shown in Figure 6 is identical to the accumulator shown in Figure 7. The operation of this form of the invention is as follows: First, turn the adjustable orifice knob 113 on the timer 93 to atmospheric temperature. The handle 99 of the timer 93 is moved downwardly to bend the diaphragm 95 upwardly and move a considerable amount of air out of chamber 97 through the orifice 98 and poppet valve 98*d*. This movement of the handle 99 opens two-way valve 100 from the accumulator 82 to the starting fluid release means 103 and oil flows from the accumulator to the chamber 106 in the starting fluid release means thus opening valve 109 against the pressure of the spring 110 to let ether flow to the intake manifold of the diesel engine. At the same time the handle 80 on hydraulic cranking motor 79 is moved to open the valve in the hydraulic cranking motor and oil flows from the accumulator 82 through the hydraulic cranking motor so that the engine is cranked. When the spring 96*a* returns the diaphragm 95 to its flat position valve 100 closes from the accumulator 82 to the starting fluid release means 103 and opens from the fluid reservoir 84 to the starting fluid release means and spring 110 moves oil from the container 104 to the fluid reservoir closing valve 109 to shut off the flow of ether to the intake manifold of the engine.

The hydraulic cranking motor 52 is shown in Figure 12. The hydraulic cranking motor 52 is comprised of a housing 113 and a hollow rod 114 reciprocably mounted in the housing and pivotally connected to the handle 80. The hollow rod 114 has apertures 115 and 116 and a pin 117 is tightly fitted in the housing 113 and a coil spring 118 is mounted on the pin and bears against an internal shoulder on the rod 114. The housing 113 has an inlet 119 and a chamber 120 spaced from the inlet and another chamber 121 spaced from chamber 120 and a passage 122 from chamber 121. A shaft 123 is rotatably mounted in the housing 113 and has a spur gear 124 reciprocably mounted thereon and spur gear moving means 125 are provided and the handle 80 is pivoted to the moving means and is also pivoted on a shaft 126 fixed in the housing 113. A carrier 127 is splined on the shaft 123 and a plurality of pistons 128 are mounted in chambers 129 in the carrier. A bearing 130 is fixed in the housing 113 at an angle from the vertical. An outlet 131 is in communication with the chamber 129 in the carrier 128. When the handle 80 is moved counterclockwise the spur gear 124 is moved into engagement with the spur gear on the flywheel 12 of the engine and rod 114 is moved to the left as shown in Figure 12 to bring apertures 115 into communication with inlet 119 and apertures 116 into communication with the chamber 120. Fluid from the accumulator 82 moves through the inlet 119 through apertures 115 into the rod 114 and into chambers 120 and 121 and then into passage 122 into the adjacent chamber 129 in the carrier 127. The fluid moves the piston 128 against the bearing 130 and the piston tends to seek a position in which it can move farther outwardly of the chamber 129 causing rotation of the carrier 127 and shaft 123. When the piston 128 is opposite the outlet 131 the fluid moves out of the particular chamber 129 and out the outlet.

The advantages of the three forms of the invention are as follows: Every part of the starting apparatus is preset before the starting operation is begun. The starting apparatus uses a minimum amount of ether for starting the engine. The starting apparatus prevents misuse of ether thus avoiding engine damage in initially starting the engine and in climbing hills and the like after the engine is running. The starting apparatus may be operated from a location remote from the engine. The starting apparatus is simple in operation. This starting apparatus will permit the engine to automatically receive a predetermined amout of priming fluid after stopping operation of the cranking motor. This is necessary at lower air temperatures. If the flow of ether is stopped at the same time the cranking motor is stopped the engine will not continue to sustain combustion. Priming must be continued until the engine will run on the regular fuel. It has been shown by experience that the engine dies rapidly once it starts, if the operator cannot resume priming fast enough to keep the engine running. This apparatus will compensate for this condition because it will permit continued injection for a predetermined time depending on the temperature setting at which the operator has set the dial. This apparatus will take the guess work out of the operator's hands during engine starting at cold temperatures. It does not require the operator to know how much ether he must apply to the engine at a given particular temperature in order to get the engine operating on its own power.

What is claimed is:

1. Apparatus for starting an internal combustion engine having a crankshaft and an intake manifold comprising a cranking motor having a shaft operatively connected to the engine crankshaft, power means in communication with the cranking motor for rotating the shaft, a container containing starting fluid under pressure, and a valve in communication with the container and the intake manifold, and a timer operatively connected with the valve, a starter mechanism for starting the motor and timer, said starter mechanism being positionable so that the cranking motor and timer are started at approximately the same time to cause cranking of the internal combustion engine and opening of the valve to let starting fluid flow to the intake manifold of the internal combustion engine, and a holding system disposed in by-pass relation to said starter mechanism for continuing, after the stopping of the cranking motor, the flow of starting fluid to the intake manifold until the timer shuts off.

2. Apparaus for starting an internal combustion engine having a crankshaft and an intake manifold comprising a cranking motor having a shaft operatively connected to the engine crankshaft, power means in communication with the cranking motor for rotating the shaft, a container containing starting fluid under pressure, a valve, a first conduit in communication with the valve and the container, a second conduit in communication with the valve and the intake manifold of the internal combustion engine, and a timer in communication with the valve, a starter mechanism for starting the motor and timer said starter mechanism being positionable so that the cranking motor and timer are started at approximately the same time to cause cranking of the internal combustion engine and opening of the valve to let starting fluid flow to the intake manifold of the internal combustion engine, and a holding system disposed in by-pass relation to said starter mechanism for continuing, after the stopping of the cranking motor, the flow of starting fluid to the intake manifold until the timer shuts off.

3. Apparatus for starting an internal combustion engine having a crankshaft and an intake manifold and a battery, a cranking motor having a shaft operatively

connected to the engine crankshaft, a timer having a contact, a relay, a valve communicating with the manifold and having a solenoid actuated by the relay to open and close the valve means electrically connecting the battery and cranking motor and timer and relay and the solenoid and including a cranking motor starter switch to open and close the means, a container containing starting fluid under pressure in communication with the valve, said timer having a closed position, said switch having a closed position for starting the cranking motor and actuating the solenoid to open the valve so that starting fluid is injected into said manifold and said switch having an open position for shutting off the cranking motor and said timer providing a delay circuit holding said valve open so that starting fluid continues to be injected until the timer shuts off.

4. Apparatus for starting an internal combustion engine comprising a battery, a cranking motor including an armature winding and a contact and a solenoid and having a shaft operatively connected to the crankshaft of the internal combustion engine, a timer graduated in degrees of temperature and having a pair of contacts, a relay including a solenoid and a pair of contacts, a valve having a solenoid actuating the relay to open and close the valve and being in communication with the intake manifold of the engine, means electrically connecting the battery and cranking motor and timer and relay and valve including a cranking motor starter button to open and close said means, and a container containing starting fluid under pressure in communication with the valve, upon setting the timer to atmospheric temperature the contacts in the timer are closed and upon pressing the cranking motor push button the solenoid in the cranking motor is energized to close the contact in the cranking motor resulting in starting of the cranking motor to crank the internal combustion engine and the solenoid on the valve opening the valve so that starting fluid is injected into the intake manifold of the internal combustion engine and upon releasing the cranking motor push button the cranking motor being shut off and starting fluid continues to be injected until the temperature pointer on the timer returns to is original position whereupon the circuit is broken through one contact in the timer.

5. Apparatus for starting an internal combustion engine having a crankshaft and an intake manifold comprising a battery, a cranking motor including an armature winding and a contact and a solenoid including a solenoid coil and a core and having a shaft operatively connected to the engine crankshaft, a timer having a dial graduated in degrees temperature and having a pair of contacts, a relay including a solenoid having a solenoid coil and a core and a pair of contacts, a valve having a solenoid actuated by the relay to open and close the valve and in communication with the intake manifold of the internal combustion engine, a first wire from the battery to the solenoid coil of the valve and having a branch wire to the solenoid coil of the relay, a second wire from the first wire to the solenoid coil of the cranking motor, a third wire from the battery through one contact in the timer to one contact in the relay, a fourth wire from the third wire through the other contact in the timer to the second contact in the relay, a fifth wire from the first wire to the armature winding in the cranking motor, a sixth wire from the contact in the cranking motor to the third wire, and a seventh wire from the solenoid coil of the cranking motor to the third wire, and a cranking motor starter button in the third wire, and a container containing starting fluid under pressure in communication with the valve, upon setting the timer the pair of contacts in the timer being closed and upon pressing the cranking motor push button the solenoid in the cranking motor being energized to close the contact in the cranking motor resulting in starting of the cranking motor to crank the internal combustion engine and one contact of the relay opening and the other contact of the relay closing and the solenoid on the valve opening the valve so that starting fluid is injected into the intake manifold of the internal combustion engine and upon releasing the cranking motor push button the cranking motor being shut off and starting fluid continues to be injected until the temperature pointer on the timer returns to its original position whereupon the circuit is broken through said other contact in the timer through opening of said other contact and said one contact of the relay closing and said other contact of the relay opening.

6. Apparatus for starting an internal combustion engine having a crankshaft and an intake manifold comprising a hydraulic cranking motor having a shaft operatively connected to the engine crankshaft and having a handle and a switch, a source of fluid under pressure in communication with the hydraulic cranking motor, a fluid reservoir in communication with the hydraulic cranking motor and the source of fluid under pressure, a battery, a timer having a pair of contacts electrically connected to the battery and the switch, a relay electrically connected to the timer, a valve having a solenoid actuated by the relay to open and close the valve and electrically connected to the relay and the battery and in communication with the intake manifold of the internal combustion engine, and a container containing starting fluid under pressure in communication with the valve, upon setting the timer the contacts being closed and upon movement of the handle fluid being moved through the hydraulic cranking motor to crank the engine and the switch being closed to cause the solenoid to be energized and open the valve to inject starting fluid into the intake manifold of the engine and starting fluid continuing to be injected into the intake manifold of the engine until the timer is shut off whereupon the circuit is broken through one contact in the timer.

7. Apparatus for starting an internal combustion engine having a crankshaft and an intake manifold comprising a hydraulic cranking motor having a shaft operatively connected to the engine crankshaft and having a handle, a source of fluid under pressure in communication with the hydraulic cranking motor, a fluid reservoir in communication with the hydraulic cranking motor and the source of fluid under pressure, a timer including a container and a diaphragm in the container and an orifice in the container and a handle connected to the diaphragm, a container containing starting fluid under pressure, a conduit leading from the container to the intake manifold of the engine, starting fluid release means including a container and a diaphragm in the container and a valve disposed in the first conduit and connected to the diaphragm and resilient means urging the valve closed, a second conduit in communciation with the source of fluid under pressure and the container of the starting fluid release means, a third conduit in communication with the second conduit and the fluid reservoir, and a two-way valve disposed at the intersection of the second and third conduits and connected to the handle and resilient means urging the diaphragm in the timer to its flat position, movement of the handle in one direction bending the diaphragm in the timer to move air out of the space in the container in communication with the orifice and opening the two-way valve from the source of fluid under pressure to the starting fluid release means to admit fluid from the source of fluid under pressure to one space in the container of the starting fluid release means to bend the diaphragm and open the valve in the starting fluid release means against the pressure of the resilient means to let starting fluid flow to the intake manifold of the engine and at the same time the handle on the hydraulic cranking motor being moved to admit fluid to the hydraulic cranking motor from the source of fluid under pressure so that the engine is cranked and upon the second resilient means returning the diaphragm of the timer to its flat position the two-way valve closing from the

source of fluid under pressure to the starting fluid release means and opening from the starting fluid release means to the fluid reservoir and the resilient means moving fluid from the container of the starting fluid release means to the fluid reservoir closing the valve in the first conduit to shut off the flow of starting fluid to the engine.

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