

March 14, 1961

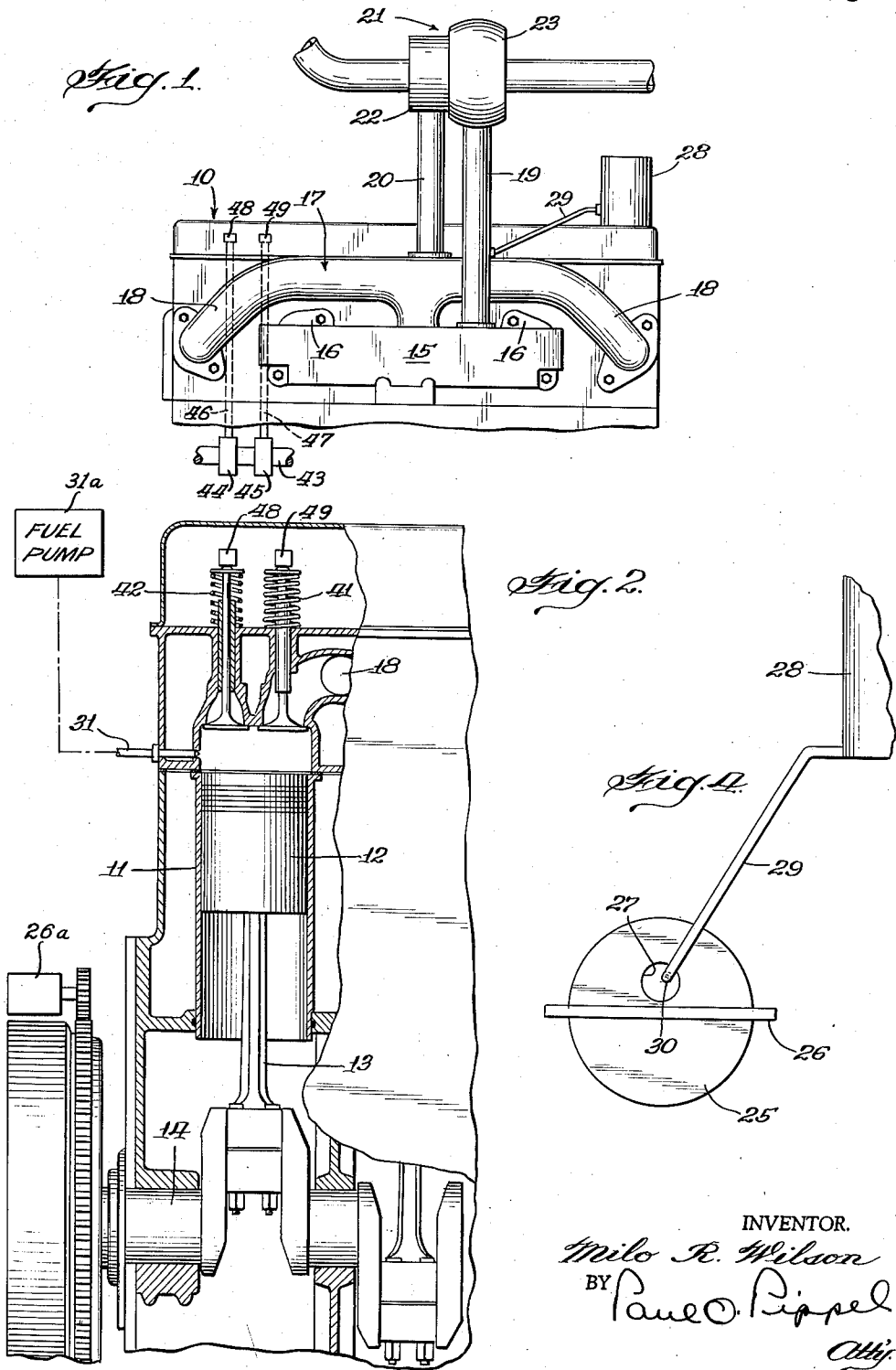
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ARRANGEMENT FOR COLD STARTING DIESEL ENGINES

Filed Sept. 30, 1957

2 Sheets-Sheet 1



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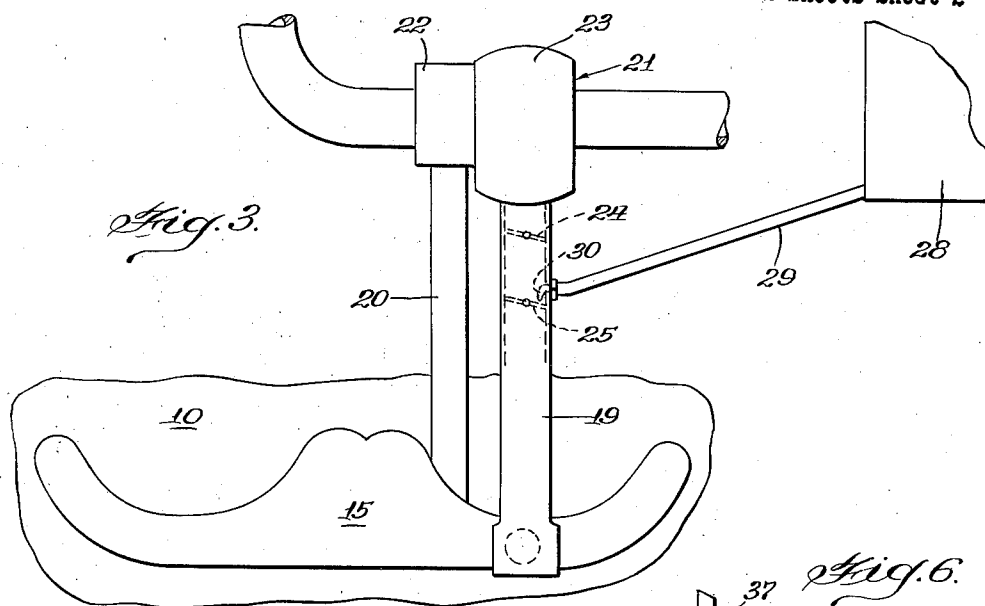
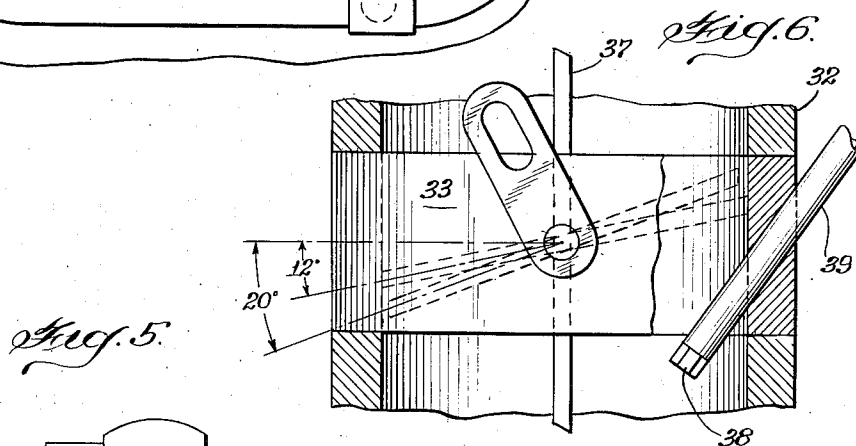
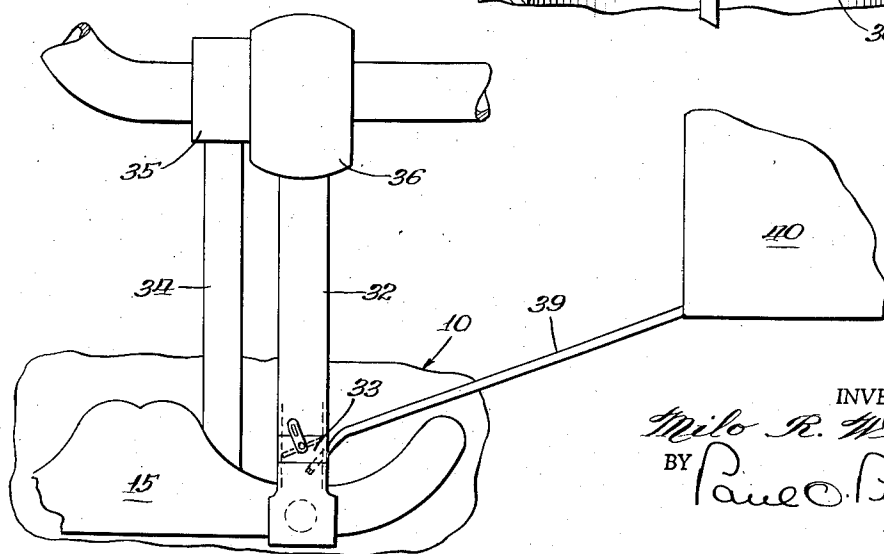
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ARRANGEMENT FOR COLD STARTING DIESEL ENGINES

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2 Sheets-Sheet 2



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2,974,659

ARRANGEMENT FOR COLD STARTING DIESEL ENGINES

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Filed Sept. 30, 1957, Ser. No. 687,237

2 Claims. (Cl. 123—180)

This invention relates to the starting of diesel engines at lower temperatures.

An object of the invention is to provide an arrangement for starting diesel engines at temperatures lower than otherwise possible and which will give a reduced consumption of starting fluid.

Another object of the invention is to provide an arrangement for starting diesel engines at lower temperatures which will reduce the cranking time of the diesel engine.

Another object of the invention is to provide an arrangement for starting diesel engines at lower temperatures which will give the diesel engine better warm up characteristics.

A further object of the invention is to provide an arrangement for starting diesel engines at lower temperatures which also serves as an emergency cut-off for stopping the diesel engine.

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 side elevational view of a diesel engine,

Figure 2 is a cross section through one of the cylinders of the diesel engine,

Figure 3 is a schematic view of the arrangement for starting a diesel engine,

Figure 4 is a detail view of the butterfly valve and fluid injector tube and the ether container,

Figure 5 is a schematic view of a modified form of arrangement for starting a diesel engine, and

Figure 6 is a cross sectional view through a portion of Figure 5 showing the modified form of butterfly valve and spray nozzle.

In the past one way of starting a diesel engine at lower temperatures has been by means of capsules containing ether. Means are provided for puncturing a capsule and upon the capsule being punctured the ether flows into the intake manifold and then into the engine cylinders where the ether is ignited by compression through cranking of the engine by means of an electric motor. The capsules must be individually loaded in the loading mechanism before they are punctured and the capsules are costly. If the diesel engine fails to fire after the first capsule is punctured the engine will be as cold as before the starting operation began upon insertion of the second capsule into the loading mechanism. Since diesel fuel is injected into the engine cylinders from the beginning of cranking by the electric motor use of a number of capsules for one starting operation may cause too much diesel fuel and too much ether to get into the cylinders causing severe detonation. Another way of starting diesel engines at lower temperatures has been by the injection of liquid ether into the intake manifold of the diesel engine by means of a hand pump. The disadvantages of this way of starting is that a fire hazard is created and the persons close to the engine breathe the ether fumes. The excess ether will also cause severe detonation and damage the engine.

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The invention proposes an arrangement for starting diesel engines at lower temperatures. The arrangement is comprised of an air intake conduit leading to the intake manifold of the diesel engine and means movably mounted in the air intake conduit so as to provide a restricted opening. A container containing starting fluid under pressure is mounted adjacent the air intake conduit and a fluid injector tube leads from the container through the air intake conduit to a position at the restricted opening. A power means is used to crank the engine and a valve on the container is opened so that starting fluid is injected into the restricted opening where it is mixed with air. This mixture then flows into the intake manifold and then into the engine cylinders where it is ignited resulting in the ignition of diesel fuel being injected into the engine cylinders at the same time to start the engine. The invention has the advantages of reduced consumption of starting fluid and reduced cranking time of the engine and gives the engine better warm up characteristics.

In the drawings, 10 generally designates a diesel engine having a plurality of cylinders 11 in each of which is disposed a piston 12 and a connecting rod 13 connects the piston to the crankshaft 14 of the engine. The diesel engine 10 has an intake manifold 15 having branches 16 in communication with the cylinders 11 and an exhaust manifold 17 having branches 18 in communication with the cylinders. The invention is concerned with the starting of diesel engines below temperatures of $+40^{\circ}$ F. In Figures 3 and 4 one form of the invention is shown. In this form an air intake conduit 19 is in communication with the intake manifold 15 and an exhaust conduit 20 is in communication with the exhaust manifold 17. A turbocharger 21 consisting of a fluid turbine 22 and a blower 23 has the fluid turbine disposed in the exhaust conduit 20 and has the blower disposed in the intake conduit 19 and the exhaust gases drive the turbine and the turbine drives the blower to draw in the air from the atmosphere into the intake conduit 19. A plate 24 is pivotally mounted in the intake conduit 19 and is manually operated and serves as an emergency cut-off to stop the diesel engine 10 when moved to a fully closed position across the intake conduit. A plate 25 is fixedly secured on a shaft 26 and the shaft is pivotally mounted in the intake conduit 19 and the plate is provided with a hole 27. The shaft 26 is manually operated to move the plate 25 to the position desired. A container 28 contains a starting fluid under pressure such as ether, and a tube 29 is in communication with the container and has a nozzle 30 mounted on its free end. The tube 29 projects through the intake conduit 19 and the nozzle 30 is disposed opposite the hole 27 in the plate 25. The operation of starting the diesel engine 10 is as follows: The plate 24 is moved to wide open position. Then the plate 25 is moved to closed position. Next, the engine speed is preset to an illustrative speed of 1000 revolutions per minute by means of the governor control. Then the diesel engine 10 is cranked by means of an electric motor 26a connected to the fly-wheel and a manually operated valve on the container 28 is opened to release the ether from the container so that the ether is sprayed out the nozzle 30 into the hole 27 of plate 25 where it is mixed with air. From the beginning of cranking of the diesel engine 10 by the electric motor 26a the injection nozzle 31 fed with diesel fuel from the governor controlled fuel injection pump or fuel pump 31a has been injecting diesel fuel into the cylinders 11 and the ether is ignited by compression and in turn ignites the diesel fuel in the cylinders, said pump 31a having the usual setting for low speed no-load operation of the engine and the usual setting for higher speed and loaded operation of the engine. After the diesel

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engine 10 is started the electric motor 26a is disconnected from the flywheel of the engine. Next the supply of ether to the tube 29 is stopped by closing the manually operated valve on the container 28. After sufficient warm up of the diesel engine 10 the plate 25 is moved to wide open position.

A modified form of the invention is shown in Figures 5 and 6. An air intake conduit 32 has a mounting member 33 interposed in it adjacent the intake manifold 15 of the diesel engine. An exhaust conduit 34 leads to the exhaust manifold 17 and a fluid turbine 35 is interposed in the exhaust conduit and a blower 36 is interposed in the intake conduit 32 with the turbine driving the blower in the manner explained for turbocharger 21 in the first form of the invention. An imperforate plate 37 is pivotally mounted in the mounting member 33 and is manually operated and seats in fully closed position in the mounting member at an angle of 12° as shown in dotted lines in Figure 6. An ether spray nozzle 38 is mounted in the mounting member 33 and is connected to tube 39 in communication with the container 40 containing ether under pressure. The operation of starting the diesel engine 10 with this form of the invention is as follows: First, the plate 37 is moved to a position 20° off its seat as shown in dotted lines in Figure 6 to provide a restricted opening. Next the engine speed is preset to the illustrative speed of 1000 r.p.m. by means of the governor control. Then the diesel engine 10 is cranked by the electric motor 26a and the manually operated valve on container 40 opened to release ether through the nozzle 38. After the diesel engine 10 is started the electric motor is disconnected from the flywheel of the engine. Next the supply of ether to nozzle 38 is stopped by closing the manually operated valve on the container 40. Then after sufficient warm up of the diesel engine 10 the plate 37 is moved to wide open position. When the plate 37 is on its seat it serves as an emergency cut-off for stopping the diesel engine 10 when it is operating on diesel fuel.

The intake and exhaust valves 42 and 41 operated by conventional valve operating means including the conventional engine crankshaft driven cam shaft 43, cam lobes 44, 45, push rods 46, 47, and rocker arms 48, 49 in each cylinder 11 of the diesel engine 10 are both open for 105° of crankshaft travel. With the plate 25 in closed position or plate 37 twenty degrees off its seat to provide a restricted opening upon stopping of the supply of ether to the nozzles 30 or 38 the diesel engine 10 will continue to run thus reducing the ether consumption. With the plates 25 or 37 in restricted opening position the pressure in the intake conduit 19 or 32 will be less than with plates 25 or 37 in wide open position and there will be less flushing through the respective intake valve 42 and cylinder 11 and exhaust valve 41. The diesel engine 10 will keep running after stopping the supply of ether to the nozzles 30 or 38 because the heat in the engine cylinders 11 is transferred to the intake manifold thus allowing the heat in the intake manifold to warm up the air introduced into other engine cylinders. Moving of the plates 25 or 37 to wide open position after stopping the supply of ether to the nozzles 30 or 38 would cause the diesel engine 10 to stop running since the pressure in the intake conduit 19 or 32 will be greater thus causing more flushing from the respective intake valve 42 and cylinder 11 and the exhaust valve 41. Ether tends to cause corrosion in the engine cylinders and reduced ether consumption means less corrosion of the engine cylinders. Above or below +20° F. the restricted openings provided by the plates 25 or 37 will reduce the cranking time of the engine since the heat in the engine cylinders is transferred to the intake manifold thus allowing the heat in the intake manifold to warm up the air introduced into other engine cylinders. With applicant's invention the diesel engine 10 has better

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warm up characteristics in that at a certain temperature less time is required to start the engine with the restricted opening provided by the plate 25 or 37 than without the restricted opening. The operator can preset all parts of the invention that require setting before starting of the diesel engine is begun and the only thing that the operator has to do is to crank the engine and release the ether from the container so that it can flow to the nozzle. Applicant's invention provides a sealed design thus eliminating fire hazard and eliminating fumes. With applicant's arrangement diesel engines have been started at temperatures as low as -25° F.

What is claimed is:

1. The method of cold-starting a compression-ignition multi-cylinder engine having a governor-controlled fuel-injection pump for delivering fuel to injection nozzles respectively for the combustion chambers of such cylinders, an air inlet passage and an air intake manifold having an air intake passage with branch passages leading respectively to the combustion chambers, and air flow control means in said inlet passage adjustable between an air throttling condition and a wide-open non-throttling condition, comprising the steps of setting the pump for low speed no-load operation of the engine, setting the air flow control means in the air throttling condition, introducing into the manifold a starting fuel having greater susceptibility to low-temperature compression ignition than the regular fuel delivered by the pump, cranking the engine until it commences to run by the energy of fuel burned in its combustion chambers, terminating introduction of the starting fuel, and warming up the engine by continued running of it solely on the regular pumped fuel in the low speed no-load operation setting while the air flow control means is in the air throttling condition.

2. A compression-ignition multi-cylinder engine adapted for cold starting, comprising combustion chambers in the head ends of the engine cylinders and each chamber having an inlet port and an exhaust port, a crankshaft, pistons operably connected with the crankshaft and reciprocative in the cylinders to reach top-dead-center while approaching the head ends of the cylinders attendant to compressing gas in the combustion chambers, an intake manifold having an air inlet and an air intake passage with branch passages leading respectively to the combustion chamber inlet ports, exhaust valves for the exhaust ports, inlet valves for the inlet ports, fuel injecting nozzles respectively communicating with the combustion chambers and for injecting fuel delivered thereto into such chambers, a governor-controlled fuel-injection pump communicating with the nozzles to deliver fuel thereto in quantities controlled by engine speed under influence of control setting of the pump, the pump being settable for low-speed no-load operation of the engine and alternatively for higher speed and loaded operation of the engine, valve operating means for opening and closing said valves and operable while each piston crosses top-dead-center to hold the exhaust valve and the inlet valve associated therewith concurrently open for substantially 105° of crankshaft rotation to incur surging of hot burned gas from the combustion chambers into the manifold branch passages, means for introducing into the manifold air inlet a starting fuel having greater susceptibility to low-temperature compression ignition than the regular fuel delivered by the pump, means for cranking the engine, and air flow control means settable in an air flow throttling condition to limit the quantity of air entering the manifold inlet during cranking and warm-up of the engine and then settable into a substantially non-throttling condition, and the starting fuel introducing means being operable to introduce such starting fuel into the air intake passage during engine cranking and to terminate such introduction of starting fuel at the end of cranking while engine warm-up occurs during low speed no-load opera-

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tion of the engine by means of fuel delivered by the pump.

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