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STARTING FLUID FOR INTERNAL COMBUSTION ENGINES

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The present invention relates to improved starting fluid compositions which are intended to facilitate the start-up of internal combustion engines at low temperatures.

Starting of internal combustion engines, whether spark-ignition or compression-ignition, under frigid conditions, that is, under the conditions when ambient temperatures fall below that of freezing, presents a rather serious problem during the winter season in the temperate zones. In the extreme Northern and Southern latitudes, this problem is particularly severe. A large number of "priming" or starting fluids and many mechanical starting aids have been proposed and employed in the past with a varying degree of success to alleviate these starting difficulties experienced during cold weather. Heretofore, diethyl ether has been considered as one of the most effective starting fluids. However, diethyl ether is ineffective at temperatures in the neighborhood of —40° F. and lower and has been observed to fail to assure satisfactory start-up of internal combustion engines even at —30° F. In all events, diethyl ether does not ignite at temperatures below —40° F., in other words, at temperatures often encountered in the Arctic and Antarctic. In view of the establishment of military bases and weather stations in these remote areas in recent years, the ability of starting internal combustion engines at freezing temperatures represents a matter of great importance.

According to the present invention, as described more fully hereinafter, internal combustion engines can be readily started at subfreezing ambient temperatures, and particularly at temperatures below —40° F., by initiating the ignition of the fuel with the aid of a new starting fluid composition representing a solution in diethyl ether of aluminum trimethyl etherate, or of aluminum triethyl etherate, which provides from about 5 to about 25%, and preferably from about 10 to 20%, by weight of trimethyl aluminum, or triethyl aluminum, in that solution.

Aluminum trimethyl and aluminum triethyl etherate complexes are formed by contacting 4 mols of a corresponding trialkyl aluminum with 3 mols of diethyl ether. Trimethyl aluminum and triethyl aluminum are available commercially, but their handling requires extreme care and precautions, because they are spontaneously inflammable in the air. However, when dissolved in diethyl ether, these trialkyl aluminum compounds form relatively stable etherate complexes. At room temperature these etherates fume but do not ignite spontaneously in the air. By following proper precautions, solutions of these etherates in diethyl ether can be prepared in the atmosphere of a neutral gas, such as nitrogen, carbon dioxide, argon, or the like. These solutions can then be employed to fill suitable discharger bulbs or cartridges, which may be pressurized with a neutral gas, for instance with nitrogen. A large variety of such bulbs or cartridges for confining starting fluids safely prior to actual use have been described in the art, in particular, in U.S. Patents 2,601,211 and 2,730,093, issued to Neely and U.S. Patent 2,516,787 issued to Moody. These containers made of a suitable material, such as an impervious plastic or a metal, can be used to introduce, either manually or by means of an automatically operated injection system, a desired quantity of the aluminum trimethyl etherate (or triethyl aluminum etherate)-diethyl ether starting fluid into the intake system and thence into the combustion chamber of an internal

combustion engine. The contents of the bulb are usually emptied into the intake manifold by opening a valve on a connection between the bulb and the manifold, this connection being attached thereto in a suitable manner, or yet by placing a number of bulbs into a container attached to the intake manifold whence it is ejected into the intake at the time of cranking, an automatic perforating mechanism piercing the bulb and releasing the fuel into the manifold and thence into the combustion chamber.

When the starting fluid mixture of diethyl ether and aluminum trimethyl (or triethyl) etherate enters the combustion chamber, while the engine is being turned over (cranked) by some available means, such as a hydraulic or electric air starter, or by a battery-driven electric motor, etc., the etherate disassociates and releases the spontaneously ignitable trimethyl aluminum (or triethyl aluminum). The glowing particles of this latter facilitates ignition of diethyl ether by the electrical spark, in the case of a spark-ignition engine, or by reason of compression, otherwise impossible on account of the low temperature about and within the engine.

Diethyl ether does not usually auto-ignite under subfreezing temperature conditions, and, in a single-cylinder CFR valve-in-head spark-ignition engine cooled with methanol, it often fails to ignite at a compression ratio of 7.25, and at all times at a compression ratio of 7.00. In contrast thereto, the combination of trimethyl aluminum (or triethyl aluminum) etherate and diethyl ether, employed as a 33.3% solution of the etherate in the ether, auto-ignites at a compression ratio of 5.25 and, in a number of instances, even at compression ratios as low as 5.00. These observations have been made while the engine was being cranked or "motored" at 600 r.p.m., using a belt-drive from a dynamo, with the jacket temperatures ranging from —8° F. to +6° F. The spark plug was removed from the engine so as to simulate in this instance the operation of a compression-ignition engine. In lieu of a manufactured bulb, a 30 ml. metal bomb was employed to contain 10 ml. of the starting fluid pressurized into the bomb with nitrogen at 275 p.s.i. This bomb was affixed onto the body of the engine through a screwed-in connection near the intake port.

Of course, the minimum compression ratio corresponding to a certain temperature of auto-ignition of aluminum trimethyl (or triethyl) etherate and diethyl ether mixture is influenced by the prevailing ambient temperatures. When ambient temperatures are higher, that is, in warmer weather, the starting fluid of the invention will auto-ignite at lower compression ratios. Thus, for instance, at room temperature, using the same CFR engine but water-cooled, at the same cranking speed of 600 r.p.m. and with the inlet air and jacket temperatures of 62–65° F., the same 33.3% solution of trimethyl aluminum (or triethyl aluminum) etherate in diethyl ether, when injected from a similar small nitrogen-pressurized steel bomb, auto-ignited at a compression ratio of 3.5. Contrary thereto, under identical conditions, that is, at room temperature, diethyl ether used alone, auto-ignited at a compression ratio of 6.8.

In another series of tests, a single-cylinder 4-cycle diesel engine, located in a cold room maintained at —50° F., was subjected to starting tests with a fuel of approximately 40 cetane number, readily pumpable at —50° F., using the particular starting fluid combination of the invention. The starting fluid was injected into the engine from pressurized primer bulbs through a connection fastened to the injection nozzle. Each bulb was filled with 7.6 ml. of the starting fluid, pressurized with nitrogen at equilibrium pressure of 250 p.s.i. The engine was cranked from fully charged storage batteries at 70° F. for a time ranging from 30 to 40 seconds, whereupon the contents of the primer bulb was released into the combustion chamber. If the ignition did not occur ("the engine did not fire") after

one minute of additional cranking, the contents of a second bulb was released. It was observed that the starting fluid of the invention, namely, 33.3% solution of trimethyl aluminum (or triethyl aluminum) etherate in diethyl ether, successfully started the engine at —40° F. and —50° F., in no event requiring the use of more than two bulbs of the fluid for each start-up.

When charged, or pressurized, into airtight bulbs or cartridges, such as are described hereinbefore, the starting fluid of the invention does not present any inordinate risks in handling, unless due to an unexpected fracture of the container and the resulting leakage. To minimize such risks, a light mineral oil, such as a lubricating oil, may be included in the combination of diethyl ether and aluminum trimethyl (or triethyl) etherate in order to reduce the concentration of aluminum trimethyl (or triethyl) etherate, without substantially decreasing thereby the ability of the starting fluid of the invention to initiate ignition at low temperatures.

Although some variations in the effectiveness of the starting fluid of the present invention may sometimes be noted when using different types of spark-ignition and compression-ignition engines and due to differences in cranking speed, as well as on account of a particular method and rate of injecting the starting fluid into the engine, these variations, if any, are minor and do not exceed the scope of the invention which is limited solely by the definitions of the following claims.

I claim:

1. A fluid composition eminently useful for starting internal combustion engines under subfreezing temperature conditions, said composition consisting essentially of diethyl ether and aluminum trialkyl etherate, selected from the group consisting of aluminum trimethyl and aluminum triethyl etherates and dissolved in said ether in an amount which provides from about 5 to about 25 percent by weight of aluminum trialkyl in the solution.

2. A fluid composition eminently useful for starting internal combustion engines under subfreezing temperature conditions, said composition consisting essentially of diethyl ether and aluminum trimethyl etherate dissolved in said ether in an amount which provides from about 5 to about 25% by weight of aluminum trimethyl in the solution.

3. A fluid composition eminently useful for starting internal combustion engines under subfreezing temperature conditions, said composition consisting essentially of diethyl ether and aluminum triethyl etherate dissolved in said ether in an amount which provides from about 5 to about 25% by weight of aluminum triethyl in the solution.

References Cited in the file of this patent

UNITED STATES PATENTS

2,575,543	Young	Nov. 21, 1951
2,699,457	Ziegler et al.	Jan. 11, 1955
2,774,656	Newman et al.	Dec. 18, 1956
2,826,598	Ziegler et al.	Mar. 11, 1958
2,842,432	Newman et al.	July 8, 1958
2,867,081	Kimmel	Jan. 6, 1959
2,934,047	Young	Apr. 26, 1960