Jan. 9, 1951 O. O. OAKS 2,537,694

INTERNAL-COMBUSTION ENGINE

Filed June 22, 1946 2 Sheets-Sheet 1

FIG. 1

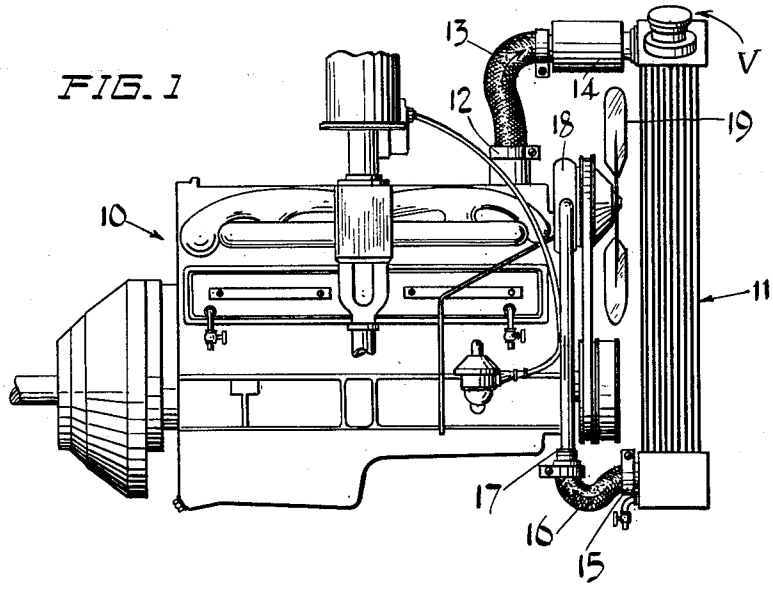


FIG. 2

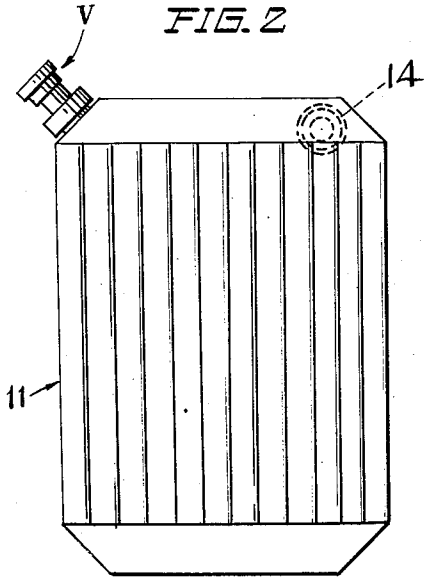
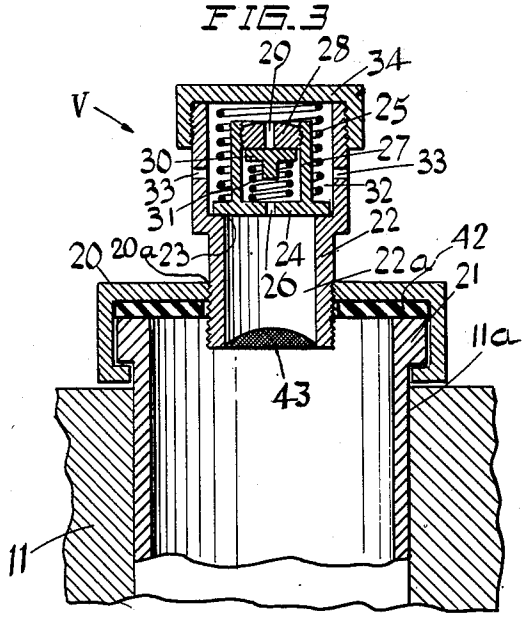


FIG. 3



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Jan. 9, 1951 O. O. OAKS 2,537,694

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Filed June 22, 1946 2 Sheets-Sheet 2

FIG. 4

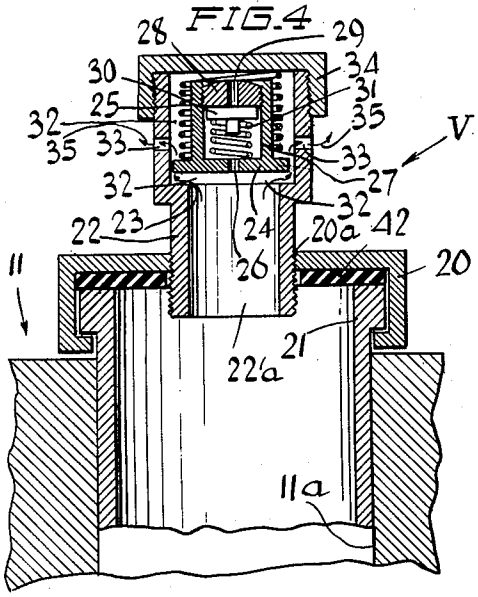


FIG. 5

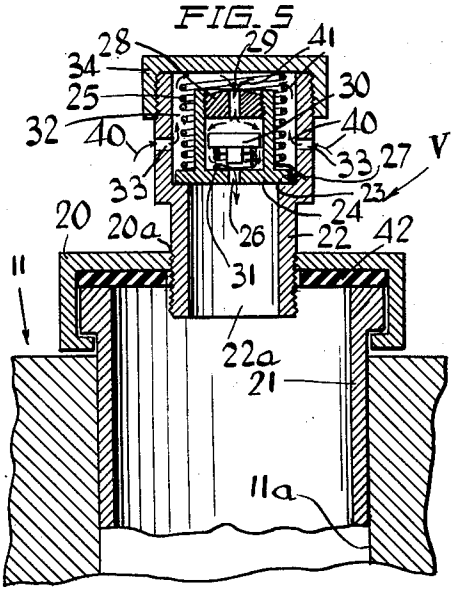


FIG. 6

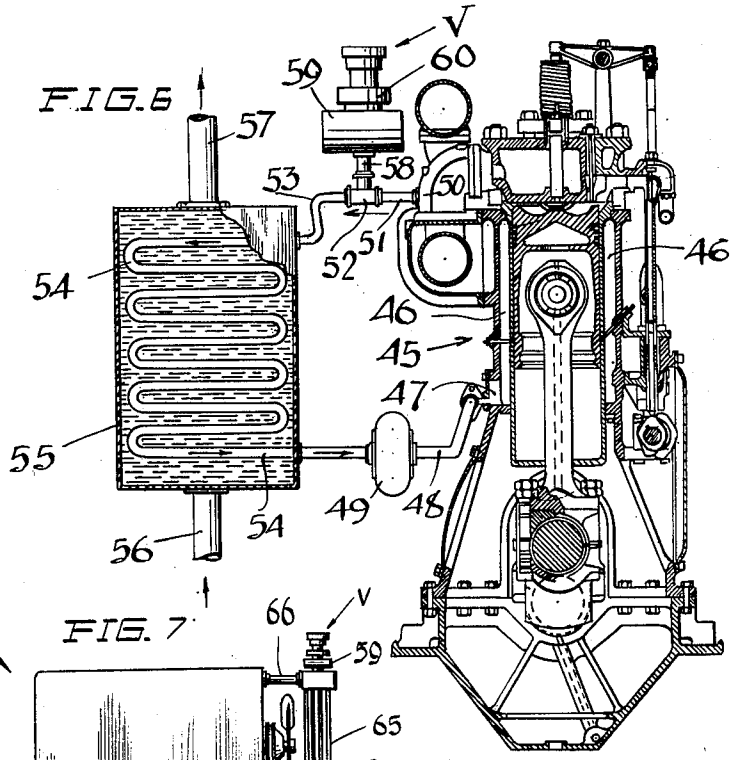
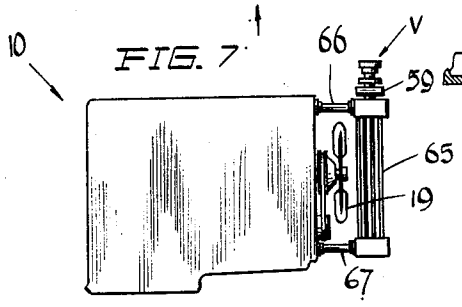


FIG. 7



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UNITED STATES PATENT OFFICE

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INTERNAL-COMBUSTION ENGINE

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Application June 22, 1946, Serial No. 678,626

1 Claim. (Cl. 123—41.1)

1

The present invention relates to improved internal combustion engines.

More particularly, the invention is directed to improved combustion engines employing a liquid of the character of tetracresylsilicate serving as the cooling medium which is circulated in the cooling channel circuit of the internal combustion engines such as spark ignited internal combustion engines of the types commonly employed in the propulsion of automobiles, airplanes, and the like, also for Diesel engines, jet propelled engines, etc.

Outstanding characteristics of tetracresylsilicate serving as such cooling medium are its boiling point of approximately 817°–825° F., its low solidifying or freezing point below —65° F., at which last named temperature it becomes viscous, its specific gravity of 1.13, its specific heat of .43, its low coefficient of expansion approximately .000047 per 1° F., its non-poisonous, non-explosive, and non-toxic attributes, and its non-corrosive characteristics with respect to copper, steel, iron, rubber and other materials commonly employed in engine construction of the types above named.

Tetracresylsilicate possesses the further advantage that throughout the range of temperature to which the cooling medium, pursuant to the invention, is subjected in the operation of internal combustion engines, including Diesel types of internal combustion engines, vaporization of the cooling medium is practically negligible.

By reason of the stated characteristics of cooling media, pursuant to the invention, the usual overflow pipe necessary when water serves as the cooling medium is eliminated. Replenishment of the cooling medium, pursuant to the invention, is not required, obviating the need of any refilling.

In cooperation with a cooling medium, pursuant to preferred practice of the invention, provision is made for maintaining substantially uniform pressure effective upon the cooling medium throughout the range of operation of the engine. Such provision of uniform pressure is preferably in the form of suitable valve means automatically operative from stage to stage of variation of the temperature of the cooling medium incident to variation of the rate of operation of the engine, as well as during the stage of starting from "cold" and during the stage between "shutting off" of the engine and consequent lowering of the temperature of the engine block and of the cooling medium from operating temperature to that of the surrounding atmosphere.

As appears from the above, and referred to more specifically hereinafter, pursuant to the invention, all danger of solidification of the cooling medium due to freezing or still lower outer atmospheric temperature, is obviated, and hence no anti-freeze material is required under low temperature exposure. Also, inhibiting materials commonly employed, pursuant to present practice, are not needed.

2

An outstanding advantage of the invention is that incrustation or other deposit of impurities commonly experienced in the use of water as the cooling medium, is wholly eliminated. This advantage is of particular value in the cooling of Diesel engines, the range of operation temperatures frequently exceeding 1000° F.

Another outstanding advantage, pursuant to the invention, is that the engine, particularly of the automotive type, may be operated over a higher range of temperature, attended by an increase in efficiency and consequent reduced consumption of fuel and lower range of reduction of temperature of the cooling medium in the course of its circulation, thus reducing the required heat exchange surface of the radiator or other supplemental cooling device. Such reduced heat exchange surface of the radiator and consequent reduced size and weight enables the radiator to be directly supported upon or integral with the engine block, in the instance of the automotive types of engines, and markedly lowered cost of cooling in the instance of Diesel types of engines.

Among other substances of general character of tetracresylsilicate as a cooling medium, pursuant to the invention, is tricresylphosphate, the properties of which include maintenance of liquid status from —65° F., at which it is viscous, to 750° F., non-toxity, non-corrosiveness to iron, steel, brass, copper and rubber, a specific gravity of 1.12, a specific heat of .45 and boiling point of 817° F. at atmospheric pressure.

In general, cooling media applicable to the invention possess the attributes of having a solidifying temperature below the minimum temperature of the outer atmosphere at the location of use of the improved internal combustion engine, a boiling point exceeding 300° F., within which temperature range of such solidifying point and boiling point the vaporization of the cooling medium is substantially negligible, also non-corrosive with respect to steel, iron, copper, brass, bronze and the like, and to rubber and other materials employed in the structure of the cooling channel circuit, also non-explosive and non-toxic, and desirably also non-poisonous, and further having such coefficient of expansion that when raised to the maximum range of temperature

at the stage of operation of the combustion engine, the expanded volume of the cooling medium is less than the capacity of the cooling channel circuit, assuming that the volume of such cooling medium charged into the cooling channel circuit at atmospheric temperature is sufficient to form therein a substantially continuous body of the cooling medium to afford circulation of the cooling medium in the cooling channel circuit.

In addition the cooling medium possesses the characteristic of being immune to oxidization by air, with or without the presence of moisture or water, within the full range of temperature of the full gamut of operation and non-operation of the combustion engine.

Further features and objects of the invention will be more fully understood from the following detailed description and the accompanying drawings, in which:

Fig. 1 is a side elevation of an internal combustion engine, of the general type employed in automobiles, equipped with my invention.

Fig. 2 is a front elevational view of the radiator shown in Fig. 1.

Fig. 3 is a detailed central sectional view, on an enlarged scale, of the valve component of the embodiment illustrated in Fig. 1. This view illustrates the positions of the parts of the valve means at the stage of non-operation of the engine and also at the stage of normal operation of the engine.

Fig. 4 is a central sectional elevation similar to that of Fig. 3, but showing the positions of the parts of the valve means at the stages of starting of the engine and during the period from starting toward the stage of normal operation.

Fig. 5 is a central sectional elevation similar to Figs. 3 and 4, but illustrating the positions of the parts of the valve means during the stage of shutting off of the engine and the cooling of the cooling medium to the outer atmospheric temperature.

Fig. 6 is a vertical sectional elevation of a Diesel type of engine equipped with my invention.

Fig. 7 is a diagrammatic elevation of an improved internal combustion engine, shown of the automotive type, equipped with a radiator of reduced heat exchange surfaces and supported unitarily with the engine block.

Referring to Figs. 1 through 5, 10 designates generally a type of engine illustrated as an internal combustion motor conventionally employed for automobiles. 11 indicates typically a radiator commonly employed with such automobile type of engine. Such conventional type of internal combustion engine, as illustrated in Fig. 1, includes a cooling channel circuit comprising the channels formed in the engine block for the passage of the cooling medium, the outflow port of which is indicated at 12 leading to the hose 13, shown as of rubber, then through the chamber 14 to the upper compartment of the radiator 11, thence through the radiator, discharging through the outlet of the radiator, indicated at 15, shown connected by the hose 16 to the pipe 17, then through the pump 18, then to the inlet of and through the cooling channels of the engine block, in return path to the radiator. As shown, and typical of many automobile types of motors, the pump is indicated as driven by a countershaft which concomitantly drives the fan 19, which cooperates with the radiator in the cooling of the cooling medium.

Fig. 1 illustrate also the typical individual supports of the engine 10 and the radiator 11, the radiator 11 being mounted stationarily relative to the chassis of the automobile and the engine 10 mounted on a cushion pad or equivalent, supported by the chassis, in which forms of individual mountings of the radiator and engine, the connections 13 and 16 are of flexible material, usually of rubber hose.

Pursuant to my invention, tetracresylsilicate is employed as the cooling medium, which is suitably supplied to the engine-radiator assembly, illustrated as utilizing the usual filling opening 11a, see Figs. 3, 4 and 5, advantageously located at or adjacent the top of the radiator 11.

The volume of tetracresylsilicate charged into the cooling channel circuit of the engine-radiator assembly, namely at outer atmospheric temperature, is less than the over-all volume of the interior of the cooling channel circuit, but sufficient to form a continuous mass of the cooling medium to afford circulation of the cooling medium by the pump, air filling any remainder of the cooling channel circuit, which may include the upper compartment of the radiator 11.

At such opening 11a, or equivalent opening leading to the upper portion of the cooling channel circuit, pursuant to the invention, there is provided valve means V serving to release the air internally of the cooling channel circuit, while excluding entry of the outer atmospheric air, during the stage of starting the engine, at which stage the engine parts are heated and therewith the cooling medium, serving also to restrict entry of the outer atmospheric air during the stage of normal operation of the engine, and also to afford entry of the outer atmosphere inwardly of the cooling channel circuit during the stage of stopping the engine and subsequent stage of the cooling of the cooling medium and of the air internally of the cooling channel circuit.

The valve means serves throughout the stages of starting and of normal operation and also of stopping and consequent cooling of the engine and appurtenant parts to maintain substantially uniform pressure within the cooling circuit substantially equal to that of the outer atmosphere.

By such construction and operation of my valve means, the rate of circulation of the cooling medium, effected by the indicated pump 18, or equivalent, is maintained in correspondence to the rate of drive of the automobile or other vehicle powered by the engine, and the pressure of the air inwardly of the cooling channel circuit is maintained substantially uniform, notwithstanding that the temperature of the cooling medium ranges from that of the outer atmosphere, namely, at the stage of starting of the engine, to an over-all operating temperature depending upon the rate of drive of the engine.

Also, by virtue of the valve means access of moisture, rain or the like within the cooling channel circuit is substantially precluded. It will be observed that in the circumstance that when any outer atmospheric air enters through the valve means, as when the engine has been stopped, the high temperature of the cooling medium evaporates any moisture or rain entrained with such entered air through the valve means, thus discharging all moisture from the cooling channel circuit and preserving the integrity of the cooling medium.

A preferred form of my valve means is illustrated in Figs. 3, 4 and 5. Such preferred embodiment of my valve means comprises a cap 20, shown detachably mounted on the tube 21, the

cap 20 and the tube 21 being arranged to make a sealing closure with the opening 11a. Sealed within an opening 20a in the cap 20 is a circular hollow housing 22 which is provided internally with an annular seat 23 upon which rests the circular valve plate 24, normally held by the expansile spring 25 in sealing engagement therewith. The valve plate 24 is provided with the opening 26 which affords communication between the interior 22a of the lower circular portion of the valve housing and the interior of the annular sub-housing 27, formed inwardly within the upper portion of the housing 22. Within the sub-housing 27 is provided the circular valve seat 28, shown screw-threadedly seated at the upper terminus of the circular wall of the sub-housing 27; the valve seat has a valve opening 29, with which cooperates the movable valve member 30, normally biased by the expansile spring 31 to close the valve opening 29.

About the circular wall of the sub-housing 27 and the circular wall of the upper portion of the housing 22, is thus formed an annular chamber 32 which is provided with one or more openings 33, leading to the outer atmosphere. The upper end of the housing 22 of the valve means is sealed by the cap 34 shown attached to the upper portion of the housing by mating screw threading. Conveniently the expansile spring 25 is housed in the annular chamber 32.

It is desirable to provide a sieve or like element, as is indicated at 43 in Fig. 3, to exclude dust or other foreign matter.

Fig. 3 illustrates the positions of the component parts of the valve means at the stage of non-operation of the engine, at which stage the cooling medium is at the temperature of the outer atmosphere. Under such condition, and assuming that the proper amount of cooling medium has been charged into the cooling channel means, upon starting the engine, the temperature of the cooling medium is gradually raised, including that of the air within the cooling channel circuit, and accordingly upon the heating of such inwardly contained air, its pressure is increased, thus causing the rise of the valve member 24 above its valve seat 23, affording flow of the heated air about the valve member 22, through the annular chamber 32 and escape through the openings 33 into the outer atmosphere, as indicated by the arrows 35, as indicated in Fig. 4.

The positions of the component parts of the valve means during the stage of starting of the engine to the stage of normal operation are indicated in Fig. 4.

Upon attaining normal operation of the engine, the component parts of my valve means are in their respective positions as shown in Fig. 3 in which status under the condition of increase in temperature of the cooling medium, incident to operating the engine at higher speed, escape of air through my valve means ensues similarly as during the stage of starting from "cold" to the stage of normal operation, as indicated in Fig. 4 and as above described.

During the stage of operation of the engine, the heat transmitted through the engine block to the cooling medium in the cooling channel circuit is reduced during its transit through the radiator, the reduction being brought about by thermal exchange with the outer air contacting the heat exchange surfaces of the radiator, as in the instance of an automobile or like vehicle in transit, enhanced by the circulation of the fan.

At the stage of stopping of the engine and consequent cooling of the cooling liquid, the component parts of my valve means take their positions indicated in Fig. 5. Such shutting off of the engine and cooling of the interior of the cooling channel circuit and the therein contained air effects a reduction of pressure inwardly of the cooling channel circuit, the thus greater pressure of the outer atmosphere causing an inward flow of the outer air, indicated by the arrows 40, through the apertures 33, thence through the opening 29 of the valve seat 28, indicated by the arrows 41, afforded by displacement of the movable valve member 30 against its expansile spring 31, thence about the movable valve member 30, then through the opening 26 of the valve plate 24, and finally into the upper region of the cooling channel circuit, such flow of the inward air being continued until the status of equalization of pressure and eventual cooling of the cooling liquid to the temperature of the outer air have taken place.

Desirably, the cap 20 is secured in position on the head of the tube 21 by bayonet joint assembly, a gasket 42 being interposed.

Fig. 1 illustrates at 14 the employment of an expansion tank, the use of which is optional, as proven by actual tests in the operation of an automotive type of engine under commercial conditions, since the dimensions of the upper compartment of a conventional radiator affords sufficient expansion of tetracresylsilicate employed as the cooling medium. In all events, sufficient capacity for expansion of tetracresylsilicate or other cooling media of like characteristics is afforded by providing sufficient capacity in the upper compartment of the radiator.

In the employment of a radiator of lesser heat exchange surfaces and consequent lesser weight, such radiator may be mounted upon the same support as the engine block and additionally obviate the use of rubber tubing, such as indicated at 13 and 16, as will be more fully set forth in connection with Fig. 7.

The invention is applicable also to Diesel types of internal combustion engines, as is indicated in Fig. 6. 45 indicates generally the Diesel engine which may be of any specific construction and organization as may be preferred, provided with a water jacket including the channels 46 which surround the respective cylinders, an inlet of such cooling channel circuit being indicated at 47, shown connected to the pipe 48 and in turn to the outlet of the pump 49. An outlet of the cooling channel circuit is indicated at 50, shown connected by the pipe 51 with the T-coupling 52 one end of which connects with the pipe 53 leading to the coil 54, shown housed within the casing 55 of the cooler, the interior of the casing 55 being supplied with cooling liquid, usually cool or chilled water, supplied, say, through the inlet pipe 56 and discharging through the outlet pipe 57. The remaining end of the T-coupling 52 leads through the pipe 58 to the expansion tank 59 which is provided at its upper opening 60 with the valve means V constructed in respect to its component parts and operating correspondingly as the valve means V hereinabove described and illustrated in preferred embodiment in Figs. 3, 4 and 5. The lower end of the coil 54 is connected to the inlet of the pump 49, as indicated in Fig. 5.

In the practice of the invention, the cooling medium, in the operation of an automobile equipped with a conventional spark-ignited internal combustion engine, having its engine block of cast iron, and co-ordinated with a conventional

radiator and conventionally geared fan and pump, ranges in temperature from approximately 214° F. to approximately 230° F. in its course of circulation. In the practice of the invention in the operation of a Diesel type of internal combustion engine, the temperature of the cooling medium ranges from approximately 100° F. to approximately 300° F. By virtue of the valve means communicating with the upper compartment of the radiator, in the instance of the stated type of automotive engine, and with an upper portion of the cooling circuit, in the instance of the Diesel type of combustion engine, the pressure of the air in the cooling circuit is maintained substantially uniform at approximately the pressure of the outer atmospheric air whereby the cooling medium pursuant to the invention is circulated without entrapment of air and consequently affording free circulation of the cooling medium. In the instance of the operation of a Diesel engine, pursuant to the invention, upon circulation of the cooling medium the air within the cooling circuit is maintained above the level of the cooling medium in the expansion tank and at a pressure substantially that of the outer atmosphere, notwithstanding variation of temperature of the cooling medium due to variation of rate of operation of the Diesel engine.

Predicated upon the results of tests in the operation of an automobile equipped with the invention, a gain of over 50 per cent in mileage per gallon of gasoline was attained over a total run of over 3,000 miles of operation of the automobile at a speed not exceeding 40 miles per hour. These tests proved also the immunity of tetracresylsilicate to cast iron, steel, brass, rubber and other materials conventionally used in the cooling channel circuit, also the absence of depletion of the tetracresylsilicate, attainment of uniform pressure of the air within the upper compartment of the radiator, higher rate of transfer of heat from the engine cylinders to the cooling medium, lower power loss in cooling of the cooling medium, substantiating the practical use of a radiator of materially less surface area of radiation and consequent lesser weight of radiator, as well as total absence of solidification of the cooling medium at low atmospheric temperature and absence of boiling of the cooling medium, and the maintenance of integrity of the cooling medium throughout the total run.

The invention is of outstanding advantage in the cooling of Diesel engines, by virtue of the maintenance of integrity of the cooling medium at the high range of temperature to which the cooling medium is subjected in the combustion of the fuel-air mixtures pursuant to the Diesel principle, and without giving rise to any incrustation or other deposit within the cooling circuit, absence of corrosion of metal and other material of the component parts of the cooling circuit, absence of evaporation of the cooling medium and consequent avoidance of replenishment of the cooling medium, and increased conversion of heat energy into power output of the engine.

From the above, it is apparent that the invention provides for an improved internal combustion engine employing a cooling medium of the stated character and providing effective cooling of the concerned engine parts to afford substantially complete combustion of the fuel, either by spark ignition or by pressure explosion, and adequate lubrication by the lubricating oil employed, whereby an increase in percentage of the energy generated by the combustion is converted into delivered power of the engine.

The invention resides also in the improved assembly of an engine block, illustrated in Fig. 7 as of the automotive type, indicated generally **10**, and a radiator **65** of reduced heat exchange surfaces supported unitarily with the engine block as by support of the radiator by the inflow tube **66** and outflow tube **67** forming part of the cooling circuit, the engine block being per se supported upon a resilient pad or equivalent, the upper compartment of the radiator **65** being provided with the above set forth valve means V, having the construction and operating as hereinabove described and as illustrated on enlarged scale in Figs. 3, 4 and 5. In such construction, to insure sufficient capacity for the expansion of the cooling medium, it is preferable to provide an expansion chamber **59** co-ordinated with the valve means V, similarly as is illustrated in Fig. 6. Such improved radiator is suitably located with respect to a fan **19**, in the assembly of internal combustion engines of the automotive type.

The engine is equipped otherwise with conventional appurtenant parts such as the pump (not shown) for circulating the cooling medium, and other appurtenant parts.

The invention is also applicable for internal combustion engines employed on airplanes, the engines or motors of many types of which are not provided with fans, the extent of heat exchange surfaces of the radiator being selected to effect adequate cooling of the cooling medium to provide efficient operation of the engine or motor, in which construction the employment of tetracresylsilicate or equivalent cooling medium by virtue of the reduced range of cooling of such cooling medium affords the omission of a fan as a supplemental cooling instrumentality.

I claim:

In a closed cooling system for an internal combustion engine using an organic silicate as the liquid heat transfer medium and including an internal combustion engine having passages for the heat transfer medium, a radiator for cooling the heat transfer medium, and upper and lower connections between the radiator and the passages of the internal combustion engine, an expansion tank connected in said upper connection, a normally closed pressure and vacuum relief valve connected in the radiator and means for circulating the organic silicate through the closed system.

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