

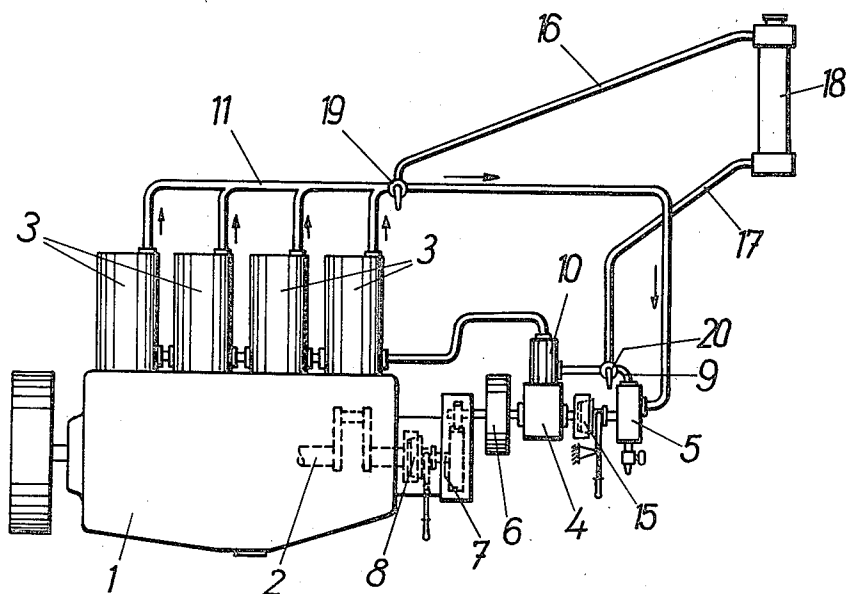
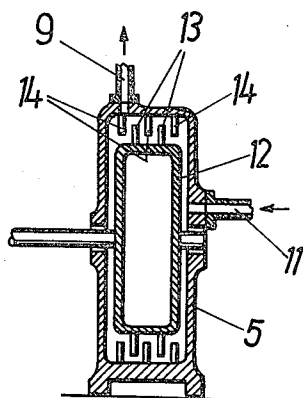
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ARRANGEMENT FOR STARTING INTERNAL COMBUSTION ENGINES

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ARRANGEMENT FOR STARTING INTERNAL COMBUSTION ENGINES

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Internal combustion engines and especially engines designed for driving vehicles are generally started by electrical power furnished by a battery. For starting vehicle and aircraft motors of higher power, e. g. in excess of 100 H. P., very large batteries are necessary for furnishing the desired energy since high internal resistance has to be overcome. Low temperatures increase the difficulties encountered in starting the respective engine since the internal resistance increases to a considerable extent due to the lubricating medium being particularly viscous at those low temperatures. Furthermore, severe cold reduces the efficiency of an electrical battery to a fraction of what it is at normal temperatures. Therefore, large vehicle and aircraft motors have already been started by means of a small internal combustion engine, especially by a gasoline engine. In this connection it is expedient prior to the starting of the main motor to heat the same by hot water which is passed through the cylinder cooling jacket to thereby facilitate the cranking of the engine and to prevent corrosion damages due to low cylinder temperatures. The said preheating may generally be effected by any device which warms or evaporates the water and must be heated by a flame; this is rather cumbersome, causes a loss of time, and represents a fire hazard.

In order to overcome these drawbacks, I have invented a new and useful device for the starting of internal combustion engines which device effects both the pre-heating as well as the cranking of such engines. The device according to my invention principally comprises an auxiliary motor which may be coupled with the main motor or main engine and a pump circulating the cooling medium of the main engine, the pump being driven by the auxiliary motor and having an internal resistance of such a magnitude as to heat or warm the cooling medium. For the purpose of starting the main motor, the device according to my invention is operated in such a manner that the auxiliary motor at first drives but the pump which exercises now two functions namely the one function of circulating the cooling medium and the other function of increasing the temperature of that medium owing to the internal resistance of the pump itself. As a result of this double function, heat is conveyed to the cylinders of the main engine by means of the warmed up or heated cooling medium. After having sufficiently pre-warmed or pre-heated the main engine in this way within a short time, the auxiliary motor is coupled to the main engine thereby cranking the same in a manner known per se.

It is a further object of my invention so to form and to dimension the circulating pump as to cause the latter to absorb and to consume the full output of the auxiliary motor at the rated speed of said auxiliary motor. Since the power required for merely circulating the cooling medium is very small compared with the power required for cranking the main engine, most of the power of the auxiliary motor may be used for warming up or heating

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the cooling medium and for speeding up the process of warming up or heating the main engine accordingly. In order to transform this major portion of the output power of the auxiliary motor within the circulating pump into heat to be taken up by the cooling medium, I design the pump so that the latter will have a correspondingly high flow resistance. As a result thereof, the pump first of all produces heat by liquid friction and circulates the warmed or heated cooling medium by means of the rest of the received power, thus rapidly increasing the temperature of the cooling medium and quickly warming up the main engine. Preferably, I design the said pump as a brake of the water whirling type.

Further objects and advantages of my invention will appear more clearly from the following specification in connection with the accompanying drawings, in which:

Fig. 1 diagrammatically illustrates a side elevation of an arrangement according to the invention.

Fig. 2 shows on a somewhat larger scale a vertical axial section through a part of the arrangement, namely the above mentioned circulating pump.

The arrangement shown in Fig. 1 comprises an internal combustion engine 1 henceforth called the "main motor," with a crank shaft 2, and a cooling jacket 3 for the motor cylinders. An auxiliary motor 4—in this example likewise an internal combustion engine—drives a circulating pump 5 and is coupled with a fly-wheel 6 of a relatively large capacity of storing up kinetic energy; via a step-down transmission 7 and a shiftable clutch 8, the auxiliary motor 4 is adapted to crank the crank-shaft 2 of the main motor. The pressure conduit 9 of the pump 5 leads to the cooling mantles 3 of the main motor, if desired via the cooling jackets 10 of the auxiliary motor 4. The reference numeral 11 designates the pipe returning the cooling medium to the pump 5.

As shown in Fig. 2, instead of having its periphery provided with blades, the rotor 12 of the circulating pump is provided with edged or round pins 13 rotating—similar to a water whirling brake—in the narrow spaces of equal pins 14 situated in the pump housing and thereby creating a strong turbulence which will absorb the larger portion of the driving power and transform it into heat thus resulting in a rapid increase of the cooling medium being circulated.

The actual starting process, i. e. the starting of the main motor is effected by throwing in the clutch 8 after the auxiliary motor 4 has sufficiently warmed up the main motor by circulating the cooling medium and while the auxiliary motor is still rotating at high speed. In this way, the stored up kinetic energy of the fly wheel 6 which likewise rotates at high speed, is taken advantage of to start rotation of the main motor. This effect is still further assisted by the torque in excess of the torque required by the whirling brake, which increases rapidly with the decreasing number of revolutions.

In addition to passing the cooling medium through the cooling jacket of the main motor, and, if desired, through the cooling jacket of the auxiliary motor, the cooling medium may suitably be passed through a cooling housing surrounding the pipe and the muffler of the auxiliary motor in order to make full use of the total waste heat of the auxiliary motor for warming up the main motor.

A further advantage of the coupling of the auxiliary motor with the combined circulating pump and the whirl brake consists in that the otherwise indispensable speed governor or speed limiting device for the starter motor can be omitted since due to the characteristic graph of the torque of rotation of the whirl brake, said torque increasing with the second power of the number of revolutions, a racing of the auxiliary motor will be safely prevented.

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In order to store a maximum amount of kinetic energy in the fly wheel 6, it is advisable, when using a relatively small auxiliary motor of low output to increase the number of revolutions of the fly wheel 6 in excess of the limit caused by the whirl brake effect of pump 5. Besides it may be desirable to accelerate the fly wheel to quite a high number of revolutions within the shortest possible time. For this purpose, according to the invention, either a shiftable coupling 15 may be provided between the auxiliary motor 4 and the pump 5, or it may be possible by suitably placed valves and vents to empty the pump 5, which acts as whirl brake during the starting process proper so that pump 5 does not act as a load to the auxiliary motor 4 when the main motor is being started.

In the state of operation after having been started, the main motor 1 works with its ordinary cooling system, e. g. with a cooling medium circuit in which its cylinder jackets 3 are connected to an air cooler 18 by pipes 16 and 17. At the branch points or mouths of the pipes 16 and 17 are respectively arranged valves 19 and 20; in such a case the valve 20 may be designed for simultaneously venting the pump 5 when emptying it.

I claim:

1. In combination with a water-jacketed internal combustion engine having a crank shaft and a starting engine for cranking said crank shaft: an energy converter operable in the manner of a liquid friction brake drivingly connected to said starting engine, conduit means connecting said energy converter with the water jacket of said internal combustion engine, said energy converter being operable to convert and convey at least the major portion of the energy output of said starting engine as heat to the cooling water for said internal combustion engine, energy storing means drivingly connected to said starting engine, and shiftable clutch means arranged between said starting engine and said crank shaft and operable selectively to effect or interrupt driving connection between said starting engine and said internal combustion engine.

2. An arrangement according to claim 1, in which said energy converter is so dimensioned as to take up the full output of said starting engine at the rated speed thereof.

3. In combination with a water-jacketed internal combustion engine having a crank shaft, and a water-cooled starting engine for cranking said crank shaft: an energy converter operable in the manner of a liquid friction brake, conduit means connecting said energy converter with the water jacket of said internal combustion engine, said energy converter being operable to convert and convey at least the major portion of the energy output of said starting engine as heat to the cooling water for said internal combustion engine, energy storing means drivingly connected to said starting engine, cooling circuit means for said starting engine, at least a portion of said cooling circuit means being connected to said conduit means, and shiftable clutch means arranged between said starting engine and said crank shaft and operable selectively to effect or interrupt driving connection between said starting engine and said internal combustion engine.

4. In combination with a water-jacketed internal combustion engine having a crank shaft, and a water-jacketed starting engine for cranking said crank shaft: conduit means interconnecting the water jackets of said engines and representing a closed cooling circuit for the jackets

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of said engines, an energy converter arranged in said cooling circuit between the water jacket outlet of said internal combustion engine and the water jacket inlet of said starting engine, said energy converter being operable simultaneously as liquid brake and pump so as frictionally to heat the water passing through said energy converter and to convey the heated up water to said water-jacketed internal combustion engine, energy storing means drivingly connected to said starting engine, and shiftable clutch means arranged between said starting engine and said crank shaft and operable selectively to effect or interrupt driving connection between said starting engine and said internal combustion engine.

5. In combination with a water-jacketed internal combustion engine having a crank shaft and a starting engine for cranking said crank shaft: an energy converter operable in the manner of a liquid friction brake drivingly connected to said starting engine, conduit means connecting said energy converter with the water jacket of said internal combustion engine, said energy converter being operable to convert and convey at least the major portion of the energy output of said starting engine as heat to the cooling water for said internal combustion engine, shiftable clutch means interposed between said starting engine and said energy converter for selectively effecting or interrupting driving connection of said energy converter with said starting engine, energy storing means drivingly connected to said starting engine, and shiftable clutch means arranged between said starting engine and said crank shaft and operable selectively to effect or interrupt driving connection between said starting engine and said internal combustion engine.

6. In combination with a water-jacketed internal combustion engine having a crank shaft and a starting engine for cranking said crank shaft: an energy converter operable in the manner of a liquid friction brake and drivingly connected to said starting engine, conduit means connecting said energy converter with the water jacket of said internal combustion engine, said energy converter being operable to convert and convey at least the major portion of the energy output of said starting engine as heat to the cooling water for said internal combustion engine, by-pass conduit means including radiator means arranged selectively to be connected with the cooling circuit for said internal combustion engine while by-passing said energy converter to thereby allow circulation of cooling water through the jacket of said internal combustion engine without passing said cooling water through said energy converter, energy storing means drivingly connected to said starting engine, and shiftable clutch means arranged between said starting engine and said crank shaft and operable selectively to effect or interrupt driving connection between said starting engine and said internal combustion engine.

7. An arrangement according to claim 1, in which said energy converter is provided with a discharging valve for draining said converter.

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