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Hartmann

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[54] **COOLING WATER CIRCULATION FOR MULTI-CYLINDER INTERNAL COMBUSTION ENGINES**

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[30] **Foreign Application Priority Data**

Nov. 5, 1970 Germany ..... P 20 54 431.4

[52] **U.S. Cl.** **123/41.74,** 123/41.1, 123/41.28, 123/41.29

[51] **Int. Cl.** **F01p 3/02,** F01p 7/16

[58] **Field of Search** 123/41.29, 41.28, 123/41.74, 41.1

[56] **References Cited**

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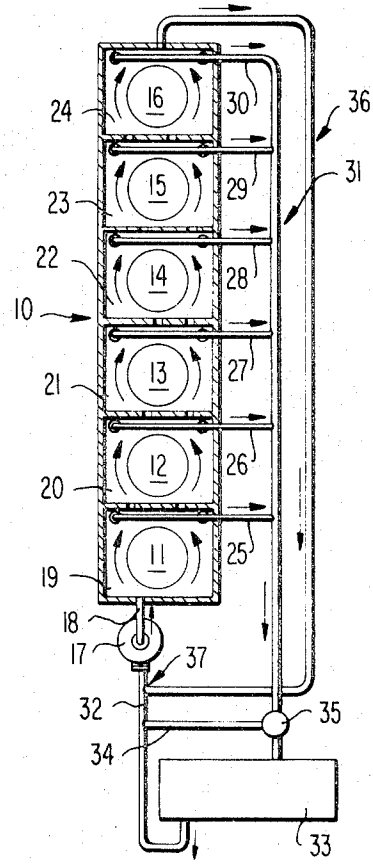
[57] **ABSTRACT**

A cooling water circulatory system for multi-cylinder internal combustion engines in which a partial cooling water quantity is branched off from the individual cooling water spaces of the cylinders that are sequentially circumcirculated by the cooling water, and in which the partial cooling water quantities are collected after passage through the respective cylinder heads in a cooling water return line whereby the cooling water space of a downstream cylinder, as viewed in the flow direction, preferably the last cylinder, is tapped by means of a by-pass line which terminates, by-passing the cylinder heads, in the cooling water line system at a place between the suction side of the cooling water pump and the cylinder heads.

15 Claims, 2 Drawing Figures



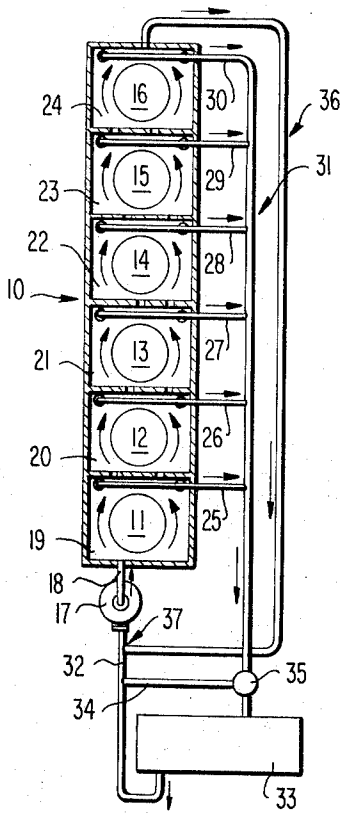

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FIG. 1

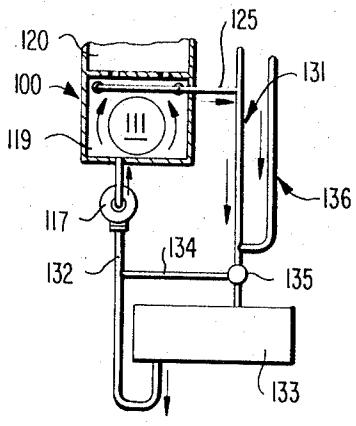
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FIG. 2

COOLING WATER CIRCULATION FOR MULTI-CYLINDER INTERNAL COMBUSTION ENGINES

The present invention relates to a cooling water circulation for multi-cylinder internal combustion engines in which a partial quantity of cooling water is branched off from each of the individual cooling water spaces of the sequentially circumcirculated cylinders and after passage through the associated cylinder head is collected in a cooling water return line.

With cooling water circulations of this type, it has been discovered that a standing cooling water column is formed in the cooling water spaces of the rear or downstream cylinders which disturbs the heat-exchange of the respective cylinders. This may lead so far that scuffing and galling occurs in these cylinders.

The present invention is concerned with the task to improve the cooling water circulatory system of the aforementioned type which is advantageous especially for the use of separate cylinder heads for the individual cylinders, in such a manner that the aforementioned disadvantages are avoided. The underlying problems are solved according to the present invention in that the cooling water space of a cylinder disposed downstream in the flow direction is tapped by means of a by-pass line and that the by-pass line in by-passing relationship to the cylinder heads terminates in the cooling water line system at a place between the suction side of the cooling water pump and the cylinder heads.

A still adequate cooling water flow is thus enforced also in the cooling water spaces of the rear or downstream cylinders by means of the by-pass line so that an over-heating and galling of the cylinders are avoided. Appropriately, one taps thereby the last cooling water space of the last cylinder so that the cylinder cooling is effectively improved at this particularly critical location.

Accordingly, it is an object of the present invention to provide a cooling water circulatory system for multi-cylinder internal combustion engines which avoids by simple means the aforementioned shortcomings and drawbacks encountered in the prior art.

Another object of the present invention resides in a cooling water circulation for multi-cylinder internal combustion engines of the type described above which assures effective and adequate cooling of all the cylinders.

A further object of the present invention resides in a cooling water circulatory system for multi-cylinder internal combustion engines which avoids galling due to overheating.

Another object of the present invention resides in a cooling water circulation for multi-cylinder internal combustion engines in which the cooling water flows sequentially from cylinder to cylinder, and which is so constructed and arranged as to improve the cooling of the cylinders.

These and other objects, features and advantages of the present invention will become more apparent from the following description when taken in connection with the accompanying drawing, which shows schematically only, two embodiments in accordance with the present invention, and wherein:

FIG. 1 is a schematic view of a first embodiment of a cooling water circulatory system in accordance with the present invention of a six-cylinder in-line engine; and

FIG. 2 is a partial schematic view of a modified embodiment of the cooling water circulatory system generally similar to FIG. 1.

Referring now to the drawing, and more particularly to FIG. 1, the engine is generally designated in this figure by reference numeral **10** and the cylinders, indicated only schematically by reference numerals **11** to **16.** The engine **10** drives a cooling water pump **17** in a conventional manner which forces the cooling water by way of the pressure line **18** successively through the individual cooling water spaces **19** to **24** of the cylinders **11** to **16.** A partial cooling water quantity for the cooling of the associated cylinder head is branched off from each cooling water space **19** to **24.** The partial cooling water quantities are returned from the cooling water spaces of the cylinder head by means of branch lines **25** to **30** into a return line **31.**

A radiator **33** and a by-pass line **34** are interconnected in conventional, known parallel arrangement between the return line **31** and the suction line **32** of the cooling water pump **17,** which are controlled in a customary manner by a thermostatic control valve **35.**

According to the present invention, the cooling water space **24** of the last cylinder **16,** as viewed in the flow direction of the cooling water, is tapped by a by-pass line **36** which, in by-passing relationship of the cooling water spaces of the cylinder head, is directly connected at **37** with the suction line **32** of the cooling water pump **17.** It is avoided by the use of the by-pass line **36** that a standing cooling water column may form in the rear or downstream cooling water spaces, for example, in the cooling water spaces **22** to **24.** The by-pass line **36** constitutes a by-pass connection between the cooling water pump **17** and the cooling water spaces **19** to **24** of the cylinders which improves the hot-running behavior of the engine.

In the modified embodiment of FIG. **2,** in which similar parts are designated by similar reference numerals of the 100 series, the main cooling water circulation is constructed corresponding to that of FIG. **1.** Of the six-cylinder in-line engine generally designated by reference numeral **100,** only the front cylinder **111** and the two first cooling water spaces **119** and **120** of the cylinders are shown in FIG. **2.** The branch line **125** of the first cylinder head terminates in the return line indicated by reference numeral **131.** A radiator **133** and a by-pass line **134** are again interconnected in parallel arrangement between the suction line **132** of the cooling water pump **117** and the return line **131,** which are controlled by a thermostatic control valve **135.**

Corresponding to the arrangement in FIG. **1,** the cooling water space of the last cylinder (not illustrated), is tapped corresponding to the arrangement of FIG. **1** by a by-pass line **136** which is connected to the return line **131** at a place **137** directly upstream of the valve **135.** As a result thereof, the parallel arrangement **133** to **135** is connected between the by-pass line **136** and the suction line **132** whereby a lesser flow quantity establishes itself in the by-pass line **136** with the same pump output than in the arrangement according to FIG. **1.** Consequently, the line cross sections of the normal cooling water circulation can be taken over possibly unchanged for the cooling water circulatory system according to the present invention.

While I have shown only two embodiments in accordance with the present invention, it is obvious that the same is not limited thereto but is susceptible of numerous changes and modifications as known to those skilled in the art. For example, the present invention is applicable to any cooling water system for internal combustion engines in which the cooling water flows through series-connected cooling water spaces of the engine. Additionally, the particular manner of cooling the cylinders may be varied as known in the art. Hence, I do not wish to be limited to the details shown and described herein but intend to cover all such changes and modifications as are encompassed by the scope of the appended claims.

What I claim is:

1. A cooling water circulatory system for multicylinder internal combustion engines with cooling water line system containing a cooling water pump, in which cooling water spaces are provided for respective cylinders through which the cooling water flows, in which a partial cooling water quantity is branched off from the individual cooling water spaces for cooling the associated cylinder heads and in which the partial cooling water quantities are collected after passage through these cylinder heads in a cooling water return line, characterized in that a cooling water space of a cylinder disposed downstream in the flow direction is tapped by means of a by-pass line means, and in that the by-pass line means in by-passing the cylinder heads is in communication with the suction side of the cooling water pump.

2. A cooling water circulatory system according to claim **1,** characterized in that the by-pass line means is connected to the cooling water space of the last cylinder as viewed in the direction of flow of the cooling water.

3. A cooling water circulatory system according to claim **2,** characterized in that the return line from the cylinder head includes a parallel arrangement of radiator and by-pass line controlled by a thermostatic control valve means.

4. A cooling water circulatory system according to claim **3,** characterized in that the by-pass line means terminates in the line portion between the suction side of the cooling water pump and the downstream connection of the parallel arrangement consisting of radiator and by-pass line.

5. A cooling water circulatory system according to claim **3,** characterized in that said by-pass line means terminates in the return line upstream of the control valve means.

6. A cooling water circulatory system according to claim **3,** characterized in that said by-pass line means terminates in the return line portion upstream of the control valve means but downstream of the first return line portion from the first cylinder head.

7. A cooling water circulatory system according to claim **1,** characterized in that the return line from the cylinder head includes a parallel arrangement of radiator and by-pass line controlled by a thermostatic control valve means.

8. A cooling water circulatory system according to claim **7,** characterized in that the by-pass line means terminates in the line portion between the suction side of the cooling water pump and the downstream connection of the parallel arrangement consisting of radiator and by-pass line.

9. A cooling water circulatory system according to claim **7,** characterized in that said by-pass line means terminates in the return line upstream of the control valve means.

10. A cooling water circulatory system according to claim **7,** characterized in that said by-pass line means terminates in the return line portion upstream of the control valve means but downstream of the first return line portion from the first cylinder head.

11. A cooling fluid circulatory system for multicylinder internal combustion engines comprising a cooling line system including respectively an intake line means, cooling pump means disposed with the intake line means, means for cooling respective cylinders of an internal combustion engine, means for collecting a partial amount of cooling fluid from said means for cooling respective cylinders, and thermostatic control valve means associated with said means for collecting; and by-pass line means extending from said means for cooling respective cylinders associated with a respective cylinder disposed downstream in the flow direction to at least one of a place at the intake means upstream in the flow direction of the cooling pump means and a place at said means for collecting upstream of the thermostatic control valve means.

12. A cooling system according to claim **11,** wherein said means for cooling respective cylinders includes chamber means associated with respective cylinders, the cooling fluid passing successively between said chamber means in the flow direction.

13. A cooling system according to claim **11,** wherein said means for collecting includes return line means, said return line means being connected to respective cylinders by branch line means.

14. A cooling system according to claim **11,** wherein said by-pass line means is connected to the means for cooling associated with the last cylinder in the direction of flow.

15. A cooling system according to claim **11,** wherein said means for collecting includes a parallel arrangement of radiator means and a second by-pass line means, said parallel arrangement disposed downstream of, and being controlled by, said thermostatic control valve means.

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