Sept. 22, 1936. H. CAMINEZ ET AL 2,054,926

COOLING SYSTEM

Filed March 17, 1933 2 Sheets-Sheet 1

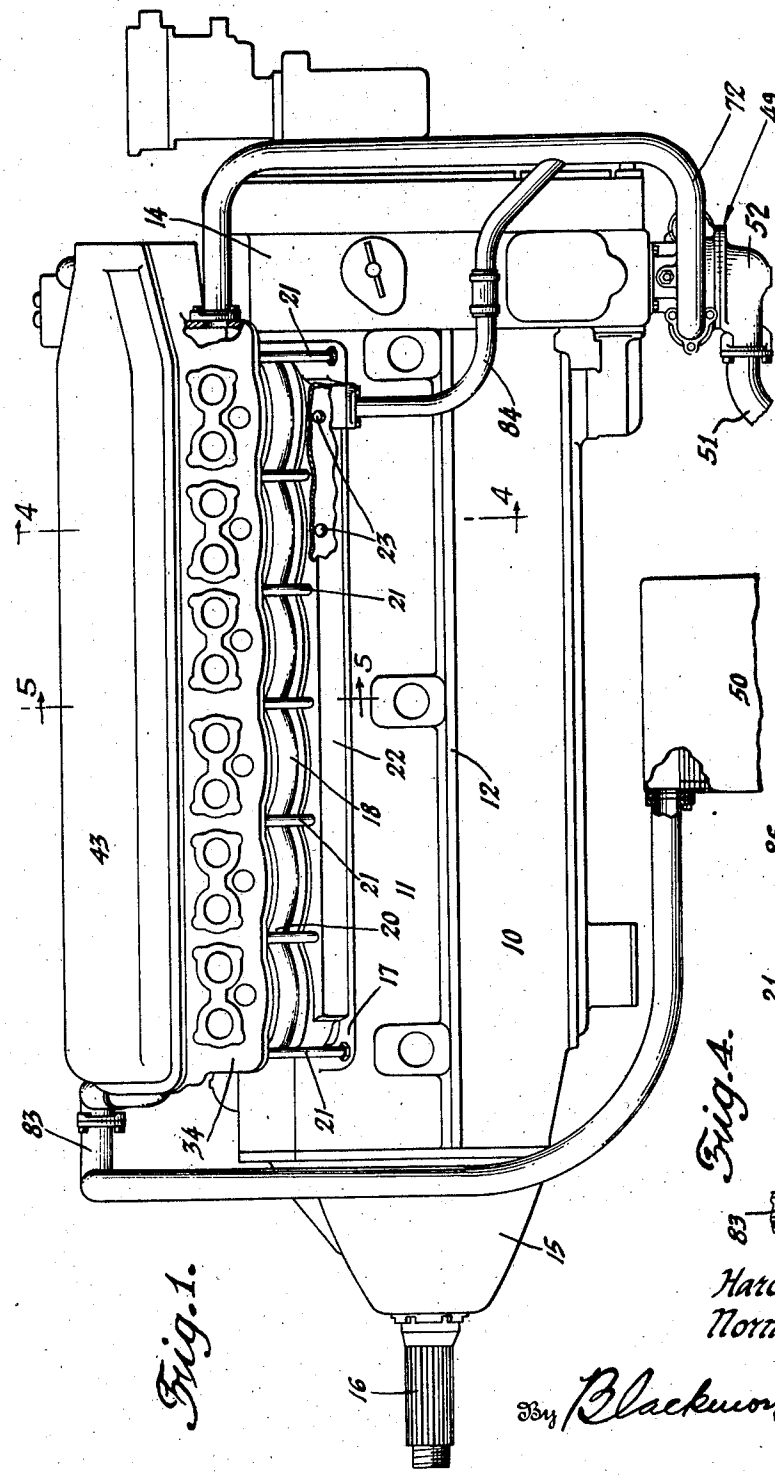


Fig. 1.

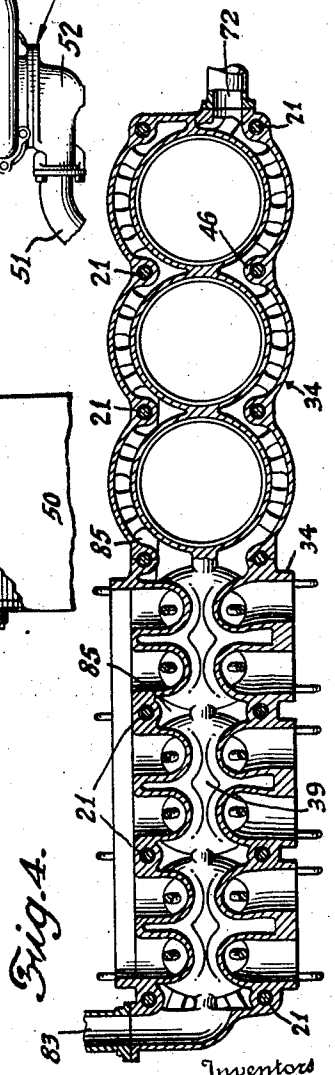


Fig. 4.

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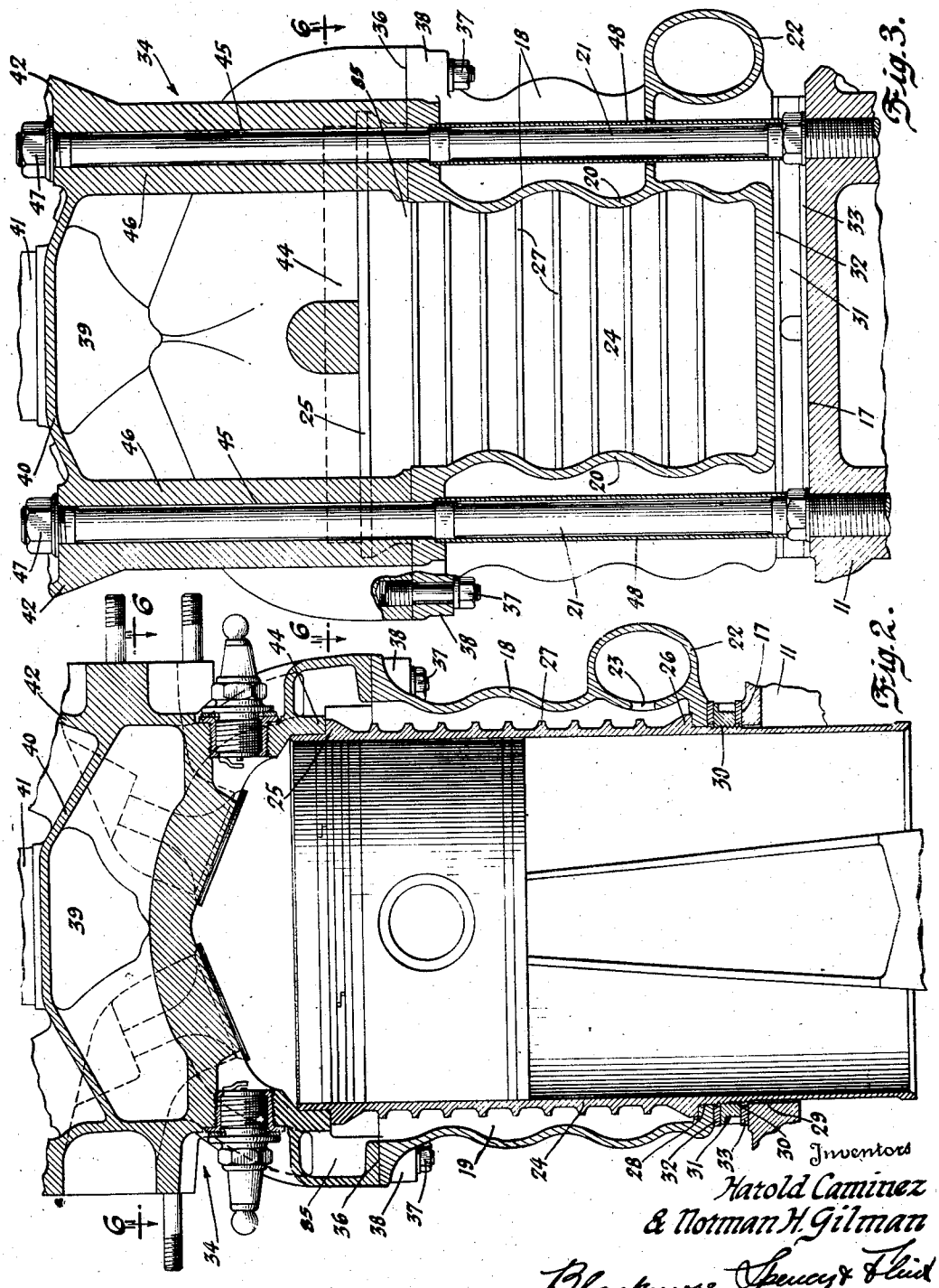


Fig. 3.

Fig. 2.

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Patented Sept. 22, 1936 2,054,926

UNITED STATES PATENT OFFICE

2,054,926

COOLING SYSTEM

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Application March 17, 1933, Serial No. 661,328

5 Claims. (Cl. 123—173)

Our invention relates to internal combustion engines designed to drive aeroplanes, dirigible balloons and like devices, although capable of use in any service wherein such an engine may be used; and relates particularly to and has for its object various improvements in and relating to the cooling systems of such engines wherein a liquid is circulated past the parts of the engine to be cooled, all as will hereinafter and at length appear.

The drawings accompanying and forming a part of this specification illustrate our invention as applied to the cooling of the cylinders and cylinder heads and valves of an internal combustion engine having twelve cylinders, arranged in two cylinder blocks of six cylinders each; the blocks being arranged at an angle of 60 degrees to one another and both being supported by a suitable crank case as is usual in V-type engines. Our invention, however, may be used in connection with other types of engine and is regarded as including such variations and modifications of the particular embodiment disclosed as come within the scope of the concluding claims, wherein the particular features wherein our invention consists are particularly pointed out and claimed.

In the drawings:

Figure 1 is a view showing a twelve cylinder V-type engine in side elevation, the same having a cooling system in accordance with our invention.

Figure 2 is a fragmentary view upon a larger scale than Figure 1, showing a section upon a vertical transverse plane indicated by the line 4—4, Figure 1; the cylinder shown being one of those of the cylinder block the nearer the observer, as will be understood.

Figure 3 is a similar view showing a section upon a plane indicated by the line 5—5, Figure 1. These figures may suggest vertically arranged cylinders, but it will be understood from Figure 1 that the cylinder blocks are inclined relative to the crank case whereby they are supported.

Figure 4 is a view showing a section upon a plane at right angles to the axes of the cylinders of the nearer block, and located near the lower limits of the cylinder head common to all the cylinders thereof, as indicated by the line 6—6, Figures 2 and 3.

Referring now to the drawings, the reference numeral 10 designates the lower and 11 the upper sections of a two-part crank case which meet in the plane 12 of the crank shaft, and between which parts the bearings for the shaft are held; and 14 designates an accessory housing secured to the rear ends of the crank case sections and which serves to support various accessory devices involved in the operation of the engine and driving means therefor, and parts and features associated therewith. The front end of the crank case has a reduction gearing housing 15 secured to it within which is gearing whereby the speed at which the propeller shaft 16 is driven is reduced to about half that of the crank shaft.

The upper part of the crank case section 11 is provided with finished surfaces inclined relative to one another so that the cylinder blocks supported upon them will stand at an angle of 60 degrees to one another, the surface which supports the nearer block, which appears in Figure 1, being indicated by the numeral 17.

The several cylinders of each cylinder block are enclosed within single piece cast aluminum alloy jackets which extend along each group and are spaced apart from the cylinders, so as to form a cooling liquid space between the cylinders and the jacket, the jacket for the nearer block being indicated by the numeral 18, and the cooling liquid space by the numeral 19. These jackets have finished upper and lower faces and the peripheral wall thereof is corrugated, as shown, the ridges or corrugations extending longitudinally of the cylinders which they enclose; and oppositely disposed portions 20 of this jacket wall are curved inwardly toward one another, as shown in Figures 1 and 3, to clear a series of tie bolts 21 whereby the jacket, the several cylinders, and the head and other parts which make up a block are held together and in place upon the inclined surfaces 17 of the upper half of the crank case. Each jacket extends throughout the length of and somewhat beyond the end cylinders of the group which it encloses and has openings through which the lower ends of the cylinders extend, and the numeral 22 designates a cooling liquid conduit located adjacent the lower end and extending along the outer side of, and which conduit is shown as formed integrally with the jacket wall. The interior of this conduit communicates with the cooling liquid space 19 through a number of holes 23 spaced along the length thereof and, while the jacket and other features are here referred to in the singular, it will be appreciated that the jackets of the two blocks are identical with one another, except that and because of the conduit 22 aforesaid they are made rights and lefts.

The cylinders of the engine, there being six in each block in the engine illustrated, are identified by the numeral 24. They are made from steel

tubes and have upper and lower external shoulders 25, 26; and ribs 27 are also preferably provided between these shoulders to stiffen the wall and increase the surface in contact with cooling liquid in the jacket space 19. The cylinders are prolonged beyond the lower shoulder 26 so that when in place their lower ends depend through holes at 28 in the bottom wall of the jacket 18 and at 29 in the inclined walls 17 and into the upper part 11 of the crank case.

The cylinders are externally threaded at 30, and the numeral 31 designates an internally threaded clamping ring engaging said threaded part; from which it follows that the jacket and cylinders, after being assembled in the manner shown, are held together by the rings and liquid tight joints are provided between the lower wall of the jacket and the cylinders, there being a ring for each cylinder as will be understood. Washers 32, 33 are commonly placed between the underside of the jacket and the clamping ring, and between the ring and the inclined surface 17 whereupon the cylinder blocks are supported.

The hollow head 34 of each cylinder block is a single unitary casting of aluminum alloy common to all the cylinders of the block, and has internal walls to isolate the combustion chambers of the cylinders from one another, to provide intake and exhaust passages, and other necessary head features; these details of head structure not being disclosed in detail as they form no part of this present invention. The lower surface of the head rests at 36 upon the upper end of the jacket 18 and the two are secured together by stud bolts 37 extending downward from the head and through holes in a flange 38 at the upper end of the jacket, a sufficient number of these being used to securely fasten the head and jacket together and secure a liquid tight joint along the meeting surface at 36. The space for cooling liquid within the head outside the walls which provide the combustion chambers and passages aforesaid extends from end to end of the block and provides an internal cooling liquid passage 39 along which a cooling liquid may flow from one end thereof to the other to cool the head, as shown in Figure 4 of the drawings. The upper wall 40 of the head carries pedestals 41 whereby the cam shaft and valve operating rockers not shown are supported; and the outer wall 42 thereof extends upward further than as shown in Figures 2 and 3 to house the valve operating mechanism, and is closed at its open top by a cover 43, Figure 1, whereby a closed chamber is provided for the said mechanism.

Formed within the head 34 and preferably located somewhat above the meeting plane 36 are annular flanges 44, one for each cylinder, which surround the upper extremities of the cylinders and against which the shoulders 25 thereof abut; and in assembling the parts the head is heated to expand the flanges 44 and the ends of the cylinders which are uppermost in the assembled block are forced into the seats provided by these flanges. Then and as the head cools the upper ends of the cylinders are grasped and compressed by the flanges and shrink joints are formed between said ends and the flanges, and the metal of the flanges is placed under tension. The jacket 18 is then put in place over the cylinders and the head and jacket secured together by the stud bolts 37, after which the lower end of the jacket and the cylinders are fastened together by the annular clamping rings 31 as hereinbefore explained. The assembled blocks are next placed upon the inclined surfaces 17 of the crank case and secured thereto by the tie bolts 21 as will be understood.

The allowance for shrinking having been chosen so as not to strain the flanges 44 beyond the elastic limit of the aluminum alloy of the head as the head cools it follows that the tendency of the flanges to contract subjects the upper ends of the cylinders to constrictive grasping forces which contribute to a marked degree to maintain liquid tight joints between the upper ends of the cylinders and the head. When in use the upper ends of the cylinders and the flanges are heated and both expand and, even though the aluminum flanges expand more per degree of temperature rise than the steel cylinders liquid tight joints will be maintained at such upper ends because the flanges were not strained beyond their elastic limit when the head cooled after the assembling as aforesaid. A grasping action upon the cylinder ends, due to the strained condition of the flanges and their tendency to contract, will therefore be maintained even when the engine is in operation and both the cylinders and head are heated to their operating temperatures.

The cylinder blocks are held to the inclined surfaces 17 of the crank case by a series of bolts 21 hereinbefore stated, these being arranged between the cylinders and at the inwardly curved portions 20 of the jacket as shown in Figures 1, 3, and 4. The lower ends of these holding bolts are threaded and screwed into threaded openings in the upper part 11 of the crank case, and they extend upward through the flange 38 of the jacket and through passages 45 in bosses 46 in the head provided by thickening the side walls thereof. Nuts 47 upon the upper ends of the rods 21 act when tightened through the flanges 44 and the upper cylinder shoulders 25, and through the walls of the cylinders to force the lower cylinder shoulders 26 against the lower jacket wall, and the rings 31 against the inclined surface 17 of the crank case, thus holding the block assembled with the crank case. As a matter of course tightening of the nuts 47 acts also to force the jacket 18 downward along with the cylinders but the cylinders, being made of steel, act as non-yielding struts subjected to longitudinal compression; whereas the jacket, being corrugated as explained, yields under compression and transmits little force to the rings 31 and to the inclined surface 17 which acts as an abutment against which force transmitted for the most part through the cylinders acts as said nuts are tightened. The cylinders being made of steel are capable of resisting large compression forces as the nuts are tightened whereas the jacket, because of its corrugated construction, yields as the nuts are tightened and transmits little force to the rings 31 and through them to the inclined surface 17 to which both cylinders and jacket are held by the bolts 21. In a word, whatever force is transmitted to the rings 31 and to the supporting surface 17 is transmitted substantially wholly through the substantially non-yieldable cylinders, because the corrugated jacket is yieldable to a degree such that no considerable force can be transmitted through it as the nuts 47 are tightened. The rods 21 are preferably reduced in diameter intermediate their ends so as not to bind in the passages 45, and their lower parts are preferably surrounded by tubes 48.

The rods 21 like the cylinders 24 are made of steel and both have the same or substantially the same coefficient of expansion per degree of tem-

perature rise as the engine becomes heated, but the cylinders attain a higher temperature than the rods and therefore expand the more during the heating process. The aluminum alloy head through which the rods extend, however, has a considerably greater coefficient of expansion than the cylinders and rods and expands at a greater rate than they expand; from which it follows that the rods are subjected to considerable strain, due to expansion of the head, as the head heats up to its operating temperature. The cross section of the rods is small as compared with that of the cylinders and they are reduced in diameter between their ends so as to avoid localization of strain at points along their length due to temperature rise as the engine becomes heated and when it is in operation.

The rods as a matter of course are not strained beyond their elastic limit due to the heating of the parts and they act always, because of their resiliency, to force the shoulders 25 against the flanges 44. The joints between the flanges and the upper ends of the cylinders are therefore placed under increased compression as the parts expand and are held the more firmly together by the elasticity of the rods and their tendency to resume their condition of initial strain due to the tightening of the nuts 47 in assembling the engine; all of which tends to maintain tightness between the flanges and the upper ends of the cylinders when the engine is in operation. Furthermore, the corrugated construction of the jacket renders it yieldable, axially, and prevents forces due to its greater expansion (it being made of aluminum alloy as explained) from being transmitted either to the joints aforesaid at the upper ends of the cylinders or to the crank case through the clamping ring 31, thus further contributing to the securing of permanent liquid tight joints between the upper ends of the cylinders and the head and between the lower end of the jacket and the lower ends of the cylinders.

Cooling liquid which may be of any suitable kind is forced by a double discharge centrifugal pump 49 through two separate pipe systems, one associated with each cylinder block, to and through the cooling spaces of said block; from which blocks the liquid returns to the radiator likewise of any kind, and back to the pump through the pipe 51 and intake 52 thereof.

The cooling liquid pump is supported from the lower end of the accessory housing 14 by securing the casing thereof to the housing, and said pump is driven from the crank shaft of the engine through any suitable gearing. Two outlet pipes lead from the pump, one supplying cooling liquid to each cylinder block; one of said pipes being shown at 72, Figure 1.

While as explained any suitable cooling liquid may be used to cool the cylinders and head the system herein disclosed is designed especially for use with a liquid which may be circulated at a temperature greatly in excess of the temperature usually present in cooling systems such, for example, as ethylene glycol, which may be used at a temperature around 300° F. The cooling liquid, whatever its characteristics may be is discharged from the pump casing through two pipes; the pipe 72 supplying the nearer cylinder block being shown in Figure 1, and a similar pipe for supplying the further block, not shown.

The pipe 72 leads directly to the head 34, see Figures 1 and 4, and supplies a relatively large volume of cooling liquid to the interior thereof which flows longitudinally of said interior along the passage 39 therein and past the intake and exhaust passages, the combustion chamber walls and like head parts, and out through a pipe 83 and to a radiator and back to the pump through the pipe 51.

Leading off from the pipe 72 is a smaller branch pipe 84 which discharges into the conduit 22 at the lower end of the jacket 18, and through which a lesser volume of liquid is supplied to the space 19 within the jacket 18 enclosing the cylinders. This liquid leaves the conduit 22 through the several holes 23 and is thus distributed fairly uniformly along the length of the cylinder block; and it flows upward in the space 19 and through ports 85 leading from the upper end of said space into the cylinder head where it joins the main volume of liquid flowing along the head passage 39. The ports 85 as will be appreciated are located in close proximity to the joint between the upper ends of the cylinders and the flanges 44, so that said joint is cooled by the cooling liquid flowing through the ports and past the same. By this arrangement a large volume of cooling liquid is supplied to the head which is the hotter when the engine is in use and requires the greater cooling effect, while a smaller volume is supplied to the jacket space about the cylinders which require less cooling. The last mentioned part is distributed along the jacket space whereby each cylinder is cooled to substantially the same extent by streams of cooling liquid which to a considerable degree are kept separate from one another, as the liquid which enters at each opening 23 tends to flow upward through the jacket space 19 unmixed with liquid entering at other openings, and from the jacket space past the joints between the cylinders and the head and through the ports 85 and into the head passage 39.

Having thus described and explained our invention we claim and desire to secure by Letters Patent:

1. In a multiple cylinder internal combustion engine, a head having an internal longitudinally extending cooling liquid passage, and a plurality of internal annular flanges adjacent its lower end; a plurality of cylinders the upper ends of which lie within said flanges and which cylinders have shoulders which abut against the lower ends of said flanges, and other shoulders adjacent their lower ends; a cooling liquid jacket enclosing all of said cylinders and spaced therefrom to provide a jacket space the upper end of which communicates with the interior of said head through ports arranged adjacent said flanges, so that cooling liquid flowing therethrough will cool the joints between the upper ends of said cylinders and said flanges; a series of stud bolts whereby the upper end of said jacket is secured to the lower end of said head; means for forcing the lower end of said jacket against the shoulders aforesaid adjacent the lower ends of said cylinders, to thereby provide liquid tight joints between the lower end of said jacket and said cylinders; means for supplying cooling liquid to the lower end of said jacket; and bolts extending from the crank case of the engine through passages in said head for holding said head and cylinders in place upon said crank case.

2. In a multiple cylinder internal combustion engine, a head having an internal longitudinally extending cooling liquid passage, and a plurality of annular flanges adjacent its lower end; a plurality of cylinders the upper ends of which lie within said flanges; a cooling liquid jacket en-

closing all of said cylinders; ports whereby the interior of said jacket is placed in communication with the liquid passage in said head; bolts whereby the upper end of said jacket and the lower end of said head are fastened together; means for providing liquid tight joints between the lower end of said jacket and said cylinders; a cooling liquid supply conduit extending along the lower end of said jacket and communicating with the interior thereof at a plurality of points along said conduit; a pipe through which cooling liquid is supplied to said conduit; and a second pipe through which cooling liquid is supplied to one end of the cooling liquid passage aforesaid in said head.

3. In a multiple cylinder internal combustion engine, a plurality of cylinders arranged in line to form a cylinder block, and a head common to all said cylinders and having an internal cooling liquid passage extending longitudinally thereof; a cooling liquid jacket enclosing all of said cylinders and spaced therefrom to provide a cooling liquid space the upper end of which communicates with the passage aforesaid in said head; bolts for securing the upper end of said jacket to the lower end of said head; means for forming liquid tight joints between the lower end of said jacket and said cylinders; a cooling liquid supply conduit formed integrally with said jacket and located at the lower end thereof, and which discharges into the cooling liquid space within said jacket through a plurality of holes spaced along the same; and two cooling liquid supply pipes one connected with said conduit, and the other with one end of the cooling liquid passage in said head.

4. In a multiple cylinder internal combustion engine, a plurality of cylinders arranged in line to form a cylinder block, and a head common to all said cylinders and having an internal cooling liquid passage extending longitudinally thereof; a cooling liquid jacket enclosing all of said cylinders and spaced therefrom to provide a cooling liquid space the upper end of which communicates with the passage aforesaid in said head; bolts for securing the upper end of said jacket to the lower end of said head; means for forming liquid tight joints between the lower end of said jacket and said cylinders; a cooling liquid supply conduit formed integrally with said jacket and located at the lower end thereof, and which discharges into the cooling liquid space within said jacket through a plurality of holes spaced along the same; a cooling liquid pump; a pipe leading therefrom to the rear end of the cooling liquid passage in said head; a branch pipe leading from said pipe to the rear end of the conduit aforesaid at the lower end of said jacket; and a pipe connected with the front end of said head passage for returning cooling liquid to said pump.

5. In a multiple cylinder internal combustion engine, a head having an internal cooling liquid space, and a plurality of internal annular flanges adjacent its lower end; a plurality of cylinders the upper ends of which lie within said internal annular flanges, and which cylinders have shoulders which abut against the lower ends of said flanges, and other shoulders adjacent their lower ends; a cooling liquid jacket enclosing all of said cylinders and spaced therefrom to provide a jacket space the upper end of which communicates with the interior of said head, and the lower end of which jacket has holes through which the lower ends of said cylinders depend, and which jacket has a flange at its upper end; a series of stud bolts depending from said head and extending through holes in the flange at the upper end of said jacket whereby the upper end of said jacket is secured to the lower end of said head; internally threaded clamping rings engaging the lower parts of said cylinders and which rings clamp the lower end of said jacket adjacent the holes therein against the shoulders aforesaid adjacent the lower ends of said cylinders; means for supplying cooling liquid to the lower end of said jacket; and bolts extending from the crank case of the engine through passages in said head for holding said head and cylinders in place upon said crank case.

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