

Feb. 3, 1942.

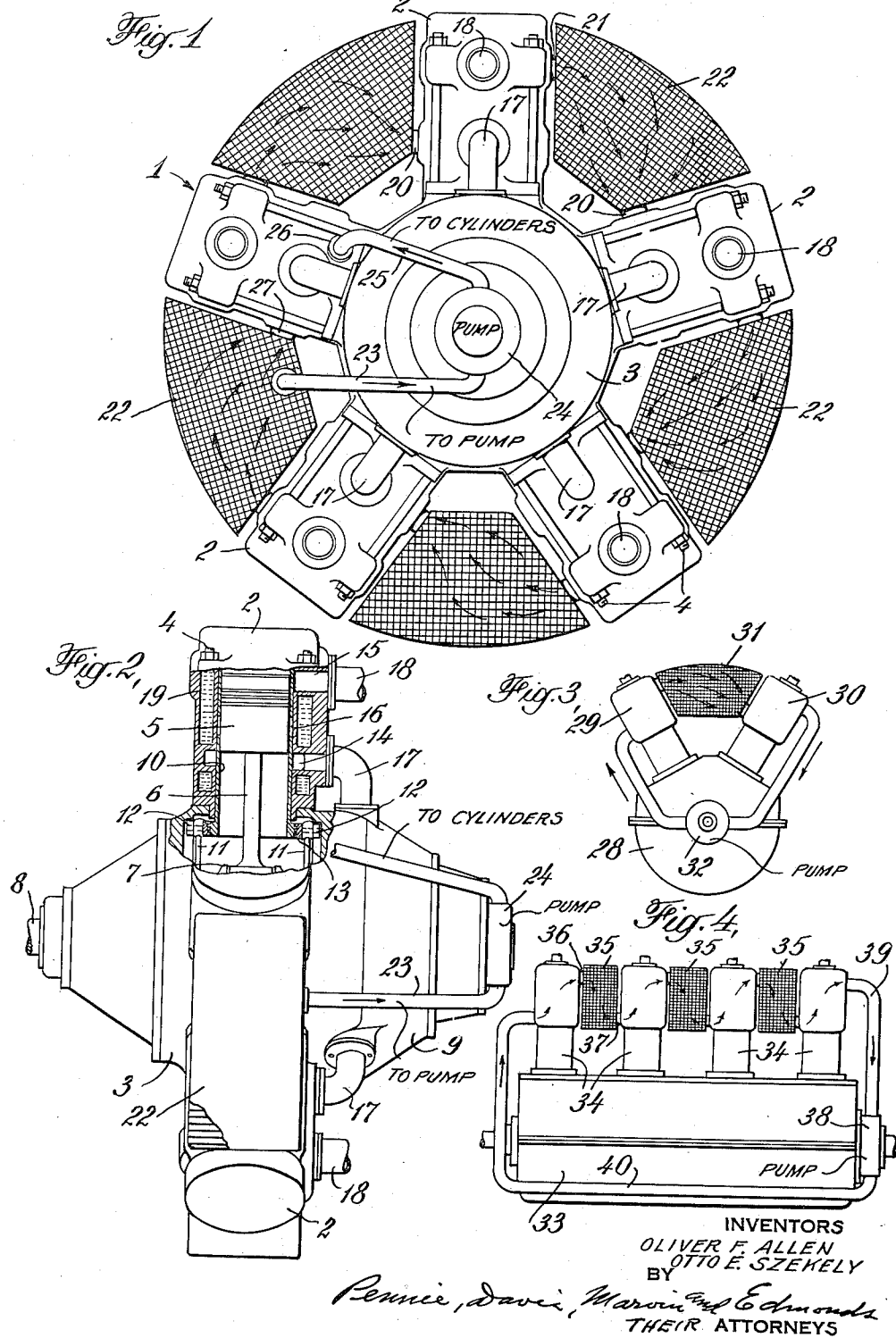
O. F. ALLEN ET AL

2,271,994

COOLING SYSTEM FOR INTERNAL COMBUSTION ENGINES

Filed March 27, 1940

2 Sheets-Sheet 1



Feb. 3, 1942.

O. F. ALLEN ET AL

2,271,994

COOLING SYSTEM FOR INTERNAL COMBUSTION ENGINES

Filed March 27, 1940

2 Sheets-Sheet 2

Fig. 5,

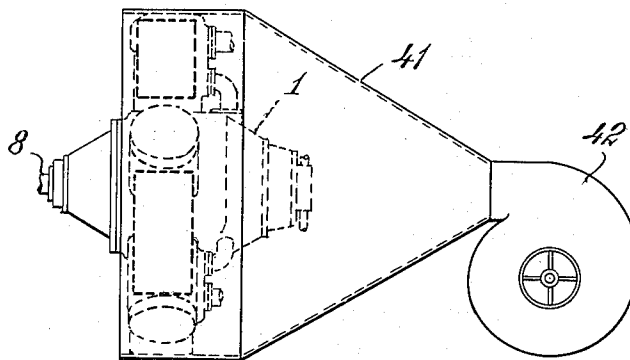


Fig. 6,

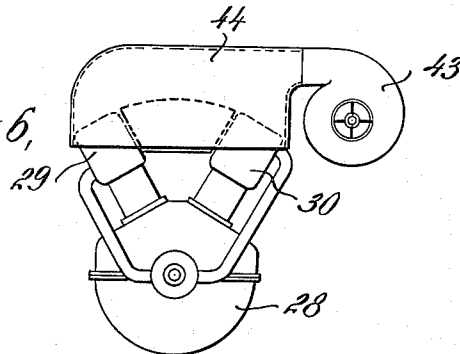
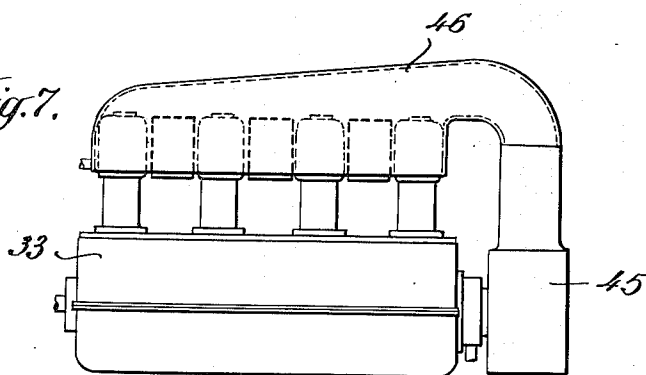


Fig. 7.



INVENTOR
OLIVER F. ALLEN
OTTO E. SZEKELY

BY

Pennie, Davis, Marvin & Edmonds
THEIR ATTORNEYS

UNITED STATES PATENT OFFICE

2,271,994

COOLING SYSTEM FOR INTERNAL
COMBUSTION ENGINES

Oliver F. Allen, New York, N. Y., and Otto E. Szekely, Philadelphia, Pa., assignors to Martin Motors, Inc., New York, N. Y., a corporation of Delaware

Application March 27, 1940, Serial No. 326,204

9 Claims. (Cl. 123—174)

This invention relates to internal combustion engines, and more particularly to the cooling of such engines, and the general object of the invention is to provide an improved cooling system for engines of this kind, and especially for engines which are cooled by the circulating of a cooling liquid.

In engines employing a liquid coolant the engine cylinders are provided with cooling liquid jackets or chambers through which the coolant (usually water or an anti-freeze solution) is passed. After traversing the cylinder jackets it is customary to circulate the liquid through a radiator of sufficient size to cool it to the desired operating temperature. The conventional radiator and engine together occupy considerable space, particularly as it is necessary to provide for the free circulation of cooling air through the cells of the radiator in order to effect proper transfer or dissipation of the heat from the cooling liquid to the air.

Hence the conventional radiator is separated from the engine, as in the ordinary automobile, and consequently more or less complicated connections between them are required. The cooling liquid must be conveyed from the engine cylinders to the circulating pump (if one is employed), from the pump to the radiator and from the radiator back to the cylinders, and, in the case of independent cylinders, there must be connections between the cylinders. Thus, much "plumbing," that is to say, interconnecting pipes and fittings are necessary, and this gives opportunity for leakage and is objectionable in other ways.

It is an object of our invention so to arrange the cooling system of the engine as to make the engine more compact so that the engine installation as a whole will occupy less space, but at the same time provide an efficiency of cooling which is equal or superior to the systems now in use.

Another object of the invention is to provide a cooling system for internal combustion engines in which the "plumbing" is reduced to a minimum.

A further aim of the invention is to provide a cooling system in which all of the cylinders inherently operate at substantially the same temperature, thereby doing away with the necessity for baffles or liquid distributing devices in the coolant circulating system.

In employing liquid-cooled engines for aircraft, particularly engines of the radial type, the "frontal area" of the combined engine and radiator is considerable, and a large portion of this

total "frontal area" must be charged to the radiator. Furthermore, in aircraft having liquid-cooled engines as heretofore constructed, the supporting of the radiator presents a problem since it must be exposed to the full sweep of the air and hence must be firmly supported, and the provision of such supports is apt to add to the complication and weight of the aircraft structure. This is true also in other applications of liquid-cooled engines, but is particularly true in connection with aircraft. A further object of the invention is, therefore, to reduce the frontal area of liquid-cooled aircraft engines, particularly those of the radial type and to simplify the problem of supporting the radiator of liquid-cooled engines generally.

When the conventional radiator is separated from the engine—either a stationary engine, a motor vehicle engine or an aircraft engine—a time element is involved in the flow of the cooling liquid through the necessary long piping or hose connections between engine and radiator. Also because of the fact that all of the cooling liquid for the engine is cooled in one large cooling vessel, or radiator, it is difficult to provide for adequate air circulation through the radiator to carry away the large quantities of heat which have swiftly to be removed in order to reduce the temperature of the liquid to the desired point. Accordingly another object of the invention is so to arrange the cooling systems of such engines as to make the radiator more effective, whereby with a radiator of given dimensions the liquid will be cooled more efficiently and to a greater extent than heretofore, or, what amounts to the same thing, the same cooling effect can be produced by a radiator of smaller total dimensions.

Other objects and advantages of our improved cooling system will appear from the following description of several embodiments of our invention as exemplified in the accompanying drawings. In these drawings:

Fig. 1 is a front elevational view of an internal combustion engine of the radial type in which the improved cooling system of our invention is embodied;

Fig. 2 is a side view of this engine with one cylinder shown partly broken away and in longitudinal section;

Figs. 3 and 4 are diagrammatic views showing modifications.

Fig. 5 is a diagrammatic view illustrating an artificial air supply for the radial engine of Figs. 1 and 2;

Fig. 6 is a diagrammatic view illustrating an air supply for the V-type engine of Fig. 3; and Fig. 7 is a diagrammatic view illustrating an air supply for the in-line engine of Fig. 4.

Referring now to the accompanying drawings, the internal combustion engine 1 shown in Figs. 1 and 2 is provided with five cylinders 2 projecting radially from, and mounted upon, a central crank case or housing 3 supporting the cylinders as well as housing the central parts of the engine. These cylinders are secured in position by any suitable means as practiced in engine building. As is usual, the cylinders are each provided with a piston 5 and connecting rods 6 which are operatively connected to a common main crank 7, the outer portion of which may be seen in Fig. 2.

Bearings for the engine crank shaft 8 are suitably arranged within the crank case or housing 3. The crank shaft projects through the engine casing at the left, as shown in Fig. 2 for its power connection to whatever apparatus is desired to be driven by the engine. On the right hand the engine shaft 8 projects a short distance for the purpose of operating whatever auxiliaries are necessary which are mounted within a housing 9.

In the internal combustion engine which has been chosen for the purpose of illustrating our invention a single sleeve valve 10 is provided for each cylinder for controlling the inlet of the fuel mixture, or charging air (as the case may be), and the discharge of the exhaust gases. These sleeve valves 10 are reciprocated in appropriately timed relation with respect to the main crank 7 by any suitable operating mechanism arranged within crank case 3. In the engine illustrated, this mechanism comprises a pair of eccentrics and eccentric straps (not shown), one mounted on main shaft 8 adjacent each side of the crank 7, and a pair of eccentric connecting rods 11 projecting outwardly from the eccentric strap and pivotally connected at 12 to a driving collar 13 which clamps around the lower projecting end of sleeve valve 10. This collar is provided with a series of internal teeth and grooves which interfit with similar teeth and grooves on the exterior of the lower projecting end of the valve sleeve 10.

The engine illustrated in the drawings is a Diesel engine and the charging air inlet ports are indicated at 14 and the exhaust ports at 15. The ports in sleeve valve 10 for controlling the inlet ports 14 are indicated at 16 and those for controlling the exhaust ports 15 are not shown as they are above the point where the cylinder is broken away in Fig. 2. The charging air is delivered to each cylinder through a conduit 17 from a suitable blower or air pump (not shown) which is arranged within housing 9 adjacent the engine frame structure. The exhaust conduits 18 from each of the cylinders may be appropriately connected to a common exhaust pipe (not shown).

It will be understood that with engines of the spark ignition type an appropriate fuel mixture instead of charging air is supplied to the engine through conduits 17 and inlet ports 14, this mixture being supplied by a carbureting device.

Each of the cylinders 2 is provided with a jacket or chamber 19 for a cooling liquid which surrounds the sides of the cylinders extending preferably from the top of each cylinder to a point inwardly of the inlet ports 14. This cham-

ber also extends within the cylinder head or cover.

Each of these cylinder jackets 19 is provided with two connections 20 and 21 for the cooling liquid, and between each pair of cylinders 2 there is arranged a radiator section 22 which is connected at one side to a connection 21 and at the other side to a connection 20 of the adjacent cylinders. These connections, though indicated diagrammatically, are preferably of a somewhat yieldable or elastic nature so as to compensate for differences in relative expansion and contraction of the radiator sections and the engine structure. Short flexible couplings, rubber hose or flexible metal hose may be used conveniently. On account of the limited weight of each of the radiator sections 22 including their liquid contents, these sections may be supported entirely by means of the liquid connections 20 and 21.

At a convenient location a conduit 23 leads from one of the radiator sections 22 to a circulating pump 24 which is driven from the engine shaft 8. A delivery pipe 25 connects the outlet of the pump to one of the cylinders as shown, for example, at 26. The connection 27 between the radiator section to which conduit 23 is connected, and its adjacent cylinder, is closed off so as to prevent the flow of fluid through this coupling, this coupling serving merely as one of the mechanical supports for the radiator section.

The direction of flow of the circulating liquid is preferably as indicated by the arrows in Fig. 1 so as to cause the cooling liquid which is at the highest temperature, namely, that in the neighborhood of the heads of the cylinders, to be delivered to the respective radiator sections, and after being cooled, the liquid from the respective sections is delivered to the inner portions of the cylinders which operate at a lower temperature than the outer ends.

By providing individual cooling radiator sections between each pair of cylinders so that there is a cooling section for each cylinder, each of these sections having substantially the same cooling surface area, it will be understood that the temperature of the cooling liquid delivered to the inlet connections of all of the cylinders will be substantially the same and that the cylinders will operate at a substantially uniform temperature.

In the modified form of our invention, as shown in Fig. 3, the engine 28 is V-type with the single cylinders or the rows of cylinders, as the case may be, 29 and 30, arranged at an acute angle to one another. A cooling radiator 31 is mounted between these cylinders in substantially the same way as described with radiator sections 22 of Fig. 1, and a circulating pump 32 arranged on the engine shaft to cause the cooling liquid to circulate through the cylinders and radiator.

In the further modified form shown in Fig. 4, the engine 33 is composed of a plurality of individual cylinders 34 arranged in line with one another and spaced apart. Between these cylinders radiator sections 35 are supported by connections 36 and 37 between adjacent pairs of cylinders. The flow of liquid as in the forms of the invention shown in Figs. 1 and 3 is outwardly with respect to each cylinder and inwardly (that is, towards the engine shaft) of each radiator section. A pump 38 on the engine shaft causes the cooling liquid to circulate through the conduits 39 and 40 and alternately

through the cylinders and radiator cooling sections.

It will be understood that with the engine as shown in Fig. 1, the cooling air to which the heat of the engine is dissipated passes through the radiator sections 22 parallel with the axis of the engine shaft 8. The circulation of this cooling air may be produced or enhanced by placing the usual air circulating fan (not shown) on the engine shaft, preferably at the right, as shown in Fig. 2, so as to cause the air to pass through the cells of the radiator sections and over and around the surfaces of the cylinders thereby cooling the engine by direct application of cooling air to the external surface of the cylinders, which air is at the same temperature as the air which is circulated through the radiator sections, instead of being at a considerably higher temperature as is the case in the ordinary engine cooling system.

In Fig. 5 there is diagrammatically illustrated an arrangement by which cooling air is supplied to the engine 1 through a housing 41 which partially surrounds the engine and conducts the air thereto from a blower 42. This blower may be driven from an extraneous source of power or may be operatively connected with the main shaft 8 of engine 1.

Air circulating fans may also be placed so as to deliver air in a similar manner to the cylinders and radiator sections of the modifications shown in Figs. 3 and 4. In the case of Fig. 3 such fan (not shown) if mounted on the shaft of engine 28 will deliver the air parallel to the engine shaft. With the engine of Fig. 3 the cooling air may also be delivered at right angles to the engine shaft and such an arrangement is shown diagrammatically in Fig. 6 where the blower 43 delivers air to a hood or housing 44 arranged above the engine to direct the air in a general downward direction through the radiator and over the surfaces of the cylinders 29 and 30. It will be understood that blower 43 may be driven from the shaft of engine 28 or in any other convenient manner.

With the engine of Fig. 4 the fan is arranged to deliver the air at right angles to the engine shaft, or in other words, from the side or top of the engine instead of from the end. As shown in Fig. 7 a blower 45, the runner of which is mounted on the shaft of engine 33, delivers its air through a suitable conduit to a hood 46 which is arranged to distribute the air downwardly around the cylinders through the several radiator sections of this engine.

By subdividing the cooling radiator of the engine into comparatively small sections and arranging these sections closely adjacent to, and preferably between, adjacent cylinders, an exceedingly compact engine occupying a minimum amount of space is provided, and the "plumbing" is greatly reduced, that is to say, the long pipe or hose lines usually employed for connecting the engine and radiator are eliminated. This permits the hot liquid from the engine cylinder jackets to pass directly and quickly to the respective radiator sections so that it enters the radiator at a higher temperature than in the conventional engine cooling system and is more efficiently cooled, there being a greater heat head between the liquid within the radiator sections and the cooling air passing through and around them.

Furthermore, there is a saving in space and complication over the conventional engine cool-

ing system construction, inasmuch as the radiator sections are supported by the liquid connections and no special trusses, cowlings or particular means of support are required. The radiator sections are readily accessible for repair, and in the case of damage to one of the radiator sections it may be temporarily disconnected from the cooling system, or it may be removed and replaced by a connecting conduit, and the engine still maintained in operation.

An important advantage of our invention when used in connection with aircraft engines of the radial type is the fact that when the radiator sections are placed between the cylinders the frontal area is not increased materially. In aircraft engines the advantages of facility of support and lightening of weight through the elimination of long hose connections and the weight of the liquid therein are to be mentioned. This reduction in volume of the cooling liquid also tends to reduce the "warming up" time of the engine.

In liquid-cooled radial engines having radiator sections placed between the cylinders, in accordance with our invention, the sweep of the air through and around the radiator sections and the cylinders themselves, whether this air current is caused by the movement of the engine through the air as in aircraft or motor vehicles, or by an artificially produced air current, as in stationary engines, uniformly contacts all of the radiator sections and the cylinders, thereby tending to eliminate "hot spots" and to produce a uniform operating temperature throughout the engine.

It will be understood that various changes can be made in the application of our invention to internal combustion engines without departing from the spirit and scope of the invention which is set forth in the appended claims. Thus, for example, while our invention is especially well adapted for use in connection with engines of the sleeve valve type on account of the absence of valve structure and valve operating mechanism between the cylinders, it will be understood that the invention can also be applied with advantage to engines having other types of valves such as poppet valves, for example.

We claim:

1. In an internal combustion engine having a plurality of cylinders arranged in spaced relation in a common plane, each cylinder having a cooling liquid chamber, the combination of a cooling liquid circulating system comprising said chambers, a cooling radiator having a plurality of sections, each of said sections being disposed adjacent a pair of cylinders, connections between the cooling liquid chambers and radiator sections arranged to direct the cooling liquid alternately through a cooling liquid chamber and a radiator section, and means for circulating said liquid.

2. In an internal combustion engine having a plurality of cylinders arranged in spaced relation in a common plane, each cylinder having a cooling liquid chamber, the combination of a cooling liquid circulating system comprising said chambers, a cooling radiator having a plurality of sections, one of which is disposed between each pair of adjacent cylinders, connections between the cooling liquid chambers and radiator sections arranged to direct the cooling liquid alternately through a cooling liquid chamber and a radiator section, and means for circulating said liquid.

3. In an internal combustion engine having a

plurality of cylinders arranged in spaced relation in a common plane, each cylinder having a cooling liquid chamber surrounding the same and extending longitudinally thereof and provided with a cooling liquid outlet near one end of the cylinder and an inlet near the opposite end thereof, the combination of a cooling liquid circulating system comprising said chambers and a cooling radiator having a plurality of sections each connected respectively to an inlet and outlet of the cooling liquid chamber of a pair of adjacent cylinders.

4. In an internal combustion engine having a plurality of cylinders arranged in spaced relation in a common plane, each cylinder having a cooling liquid chamber surrounding the same and extending longitudinally thereof and provided with a cooling liquid outlet near one end of the cylinder and an inlet near the opposite end thereof, the combination of a cooling liquid circulating system comprising said chambers and a cooling radiator having a plurality of sections, one of said sections being connected to an inlet and outlet of the cooling liquid chamber of each pair of adjacent cylinders.

5. In an internal combustion engine having a plurality of cylinders arranged in spaced relation in a common plane, each cylinder having a cooling liquid chamber, the combination of a cooling liquid circulating system comprising said chambers, a cooling radiator having a plurality of sections, said sections being disposed respectively between pairs of adjacent cylinders, and having respectively a liquid connection with the outlet of one adjacent cylinder and a liquid connection with the inlet of the other adjacent cylinder, and means for circulating the said liquid.

6. In an internal combustion engine having a plurality of cylinders arranged in spaced relation in a common plane, each cylinder having a cooling liquid chamber, the combination of a cooling liquid circulating system comprising said chambers, a cooling radiator having a plurality of sections, said sections being disposed respectively between pairs of adjacent cylinders, radiator section supporting means comprising a flexible liquid connection at each side of said respective sections, one of said connections being

secured to and connected with the outlet from one of said adjacent cylinders and the other of said connections being secured to and connected with the inlet to the other of said adjacent cylinders, and means for circulating said liquid.

7. In an internal combustion engine having a plurality of cylinders arranged in spaced relation in a common plane, each cylinder having a cooling liquid chamber, the combination of a cooling liquid circulating system comprising said chambers, a cooling radiator having a plurality of sections, said sections respectively bridging the spaces between adjacent pairs of cylinders, connections between the cooling liquid chambers and radiator sections arranged to direct the cooling liquid alternately through a cooling liquid chamber and a radiator section, and means for circulating said liquid.

8. In an internal combustion engine having a plurality of cylinders arranged in spaced relation in a common plane, each cylinder having a cooling liquid chamber, the combination of a cooling liquid circulating system comprising said chambers, a cooling radiator having a plurality of sections, said sections bridging the respective spaces between adjacent pairs of cylinders, a connection at one side of said respective radiator sections to the outlet from the adjacent cylinder, a connection at the opposite side of said sections with the inlet of the adjacent cylinder, and means for circulating said liquid.

9. In an internal combustion engine having a plurality of cylinders arranged in spaced relation in a common plane, each cylinder having a cooling liquid chamber surrounding the same and extending longitudinally thereof and provided with a cooling liquid outlet near one end of the cylinder and an inlet near the opposite end thereof, the combination of a cooling liquid circulating system comprising said chambers and a cooling radiator having a plurality of sections, said sections being disposed respectively between pairs of adjacent cylinders and being connected to an inlet and outlet of the cooling liquid chamber of each of said pairs of adjacent cylinders.

OLIVER F. ALLEN.
OTTO E. SZEKELY.