May 3, 1949. J. F. BELAIEFF 2,469,028

PLATE TYPE HEAT EXCHANGER

Filed Dec. 21, 1944 3 Sheets-Sheet 1

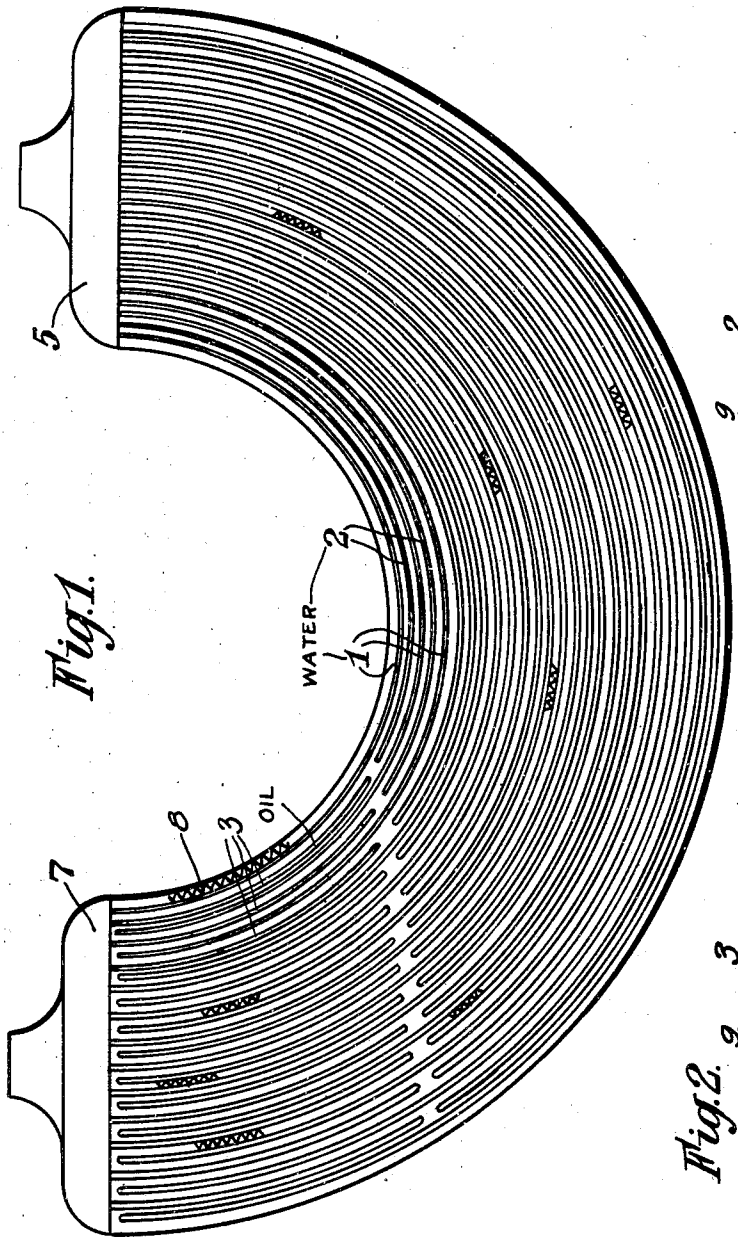

Fig. 1.

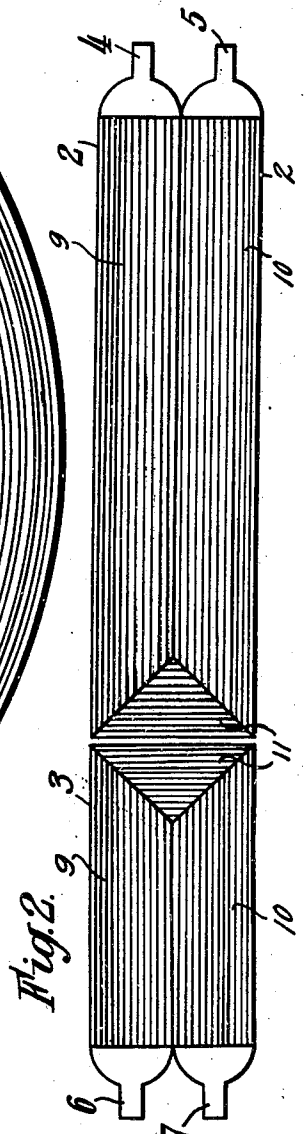

Fig. 2.

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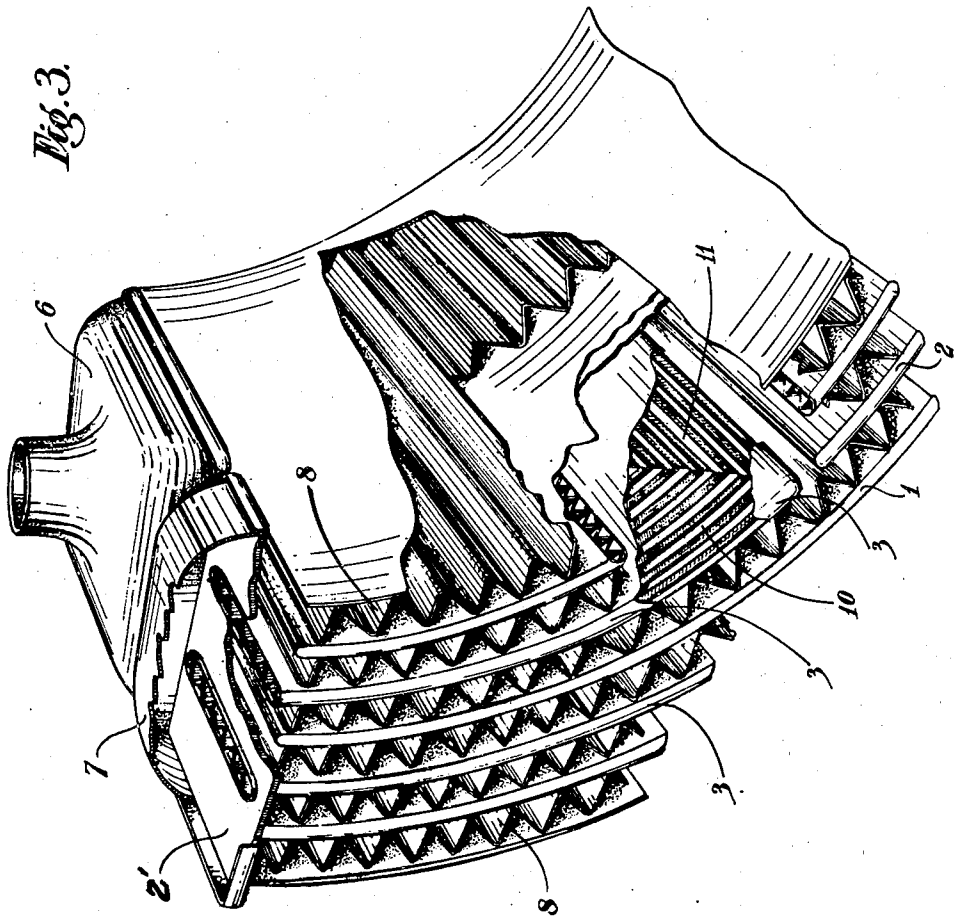
Fig. 3.



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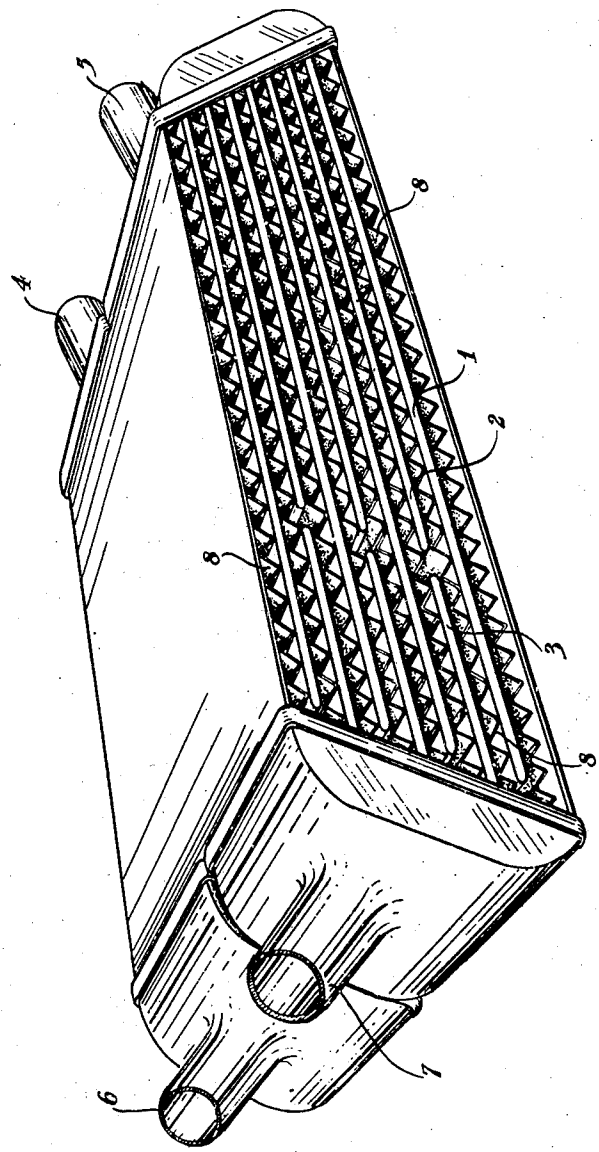

Fig. 4.

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2,469,028

PLATE TYPE HEAT EXCHANGER

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2 Claims. (Cl. 257—139)

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This invention relates to secondary surface heat exchange apparatus and in particular to apparatus comprising a heat exchange unit for oil or other viscous fluid in combination with a heat exchange unit for water, glycol or other fluid of a less viscous nature, and in particular to apparatus of annular or segmental form embodying arcuate tubes which vary in length according to the radius of the arc. The expression "secondary surface" means any surface conductively associated with the skin of the tube for the liquid to be cooled so as to increase the effective area available for the dissipation of heat.

One of the principal difficulties experienced in the design of such radiators is to arrange for the tubes of the unit for the oil or other viscous fluid to be all of the same length since coolers for such fluid which embody tubes of differing lengths usually suffer from the phenomena known as coring due to unequal flow resistance.

By coring is meant the phenomena produced by over cooling when the oil congeals on the cooling surface thus reducing the cross sectional area of the cooling passage until the flow through such passage finally stops. This usually takes place irregularly throughout the matrix so that parts only of the cooler are put out of action.

According to the present invention the tubes for the oil or other viscous fluid are all constructed to be of the same length and all or most are associated with a complementary tube for the water glycol or other less viscous fluid forming a continuation thereof to complete the arc of the annulus or segment whereby all available space is utilised.

In order that the invention may be more clearly understood reference will now be made to the accompanying drawings, wherein,

Fig. 1 is a diagrammatic elevation of one form of arcuate secondary surface heat exchange apparatus made according to the present invention comprising a combined oil cooler and water radiator for an aircraft and,

Fig. 2 is a section through the developed water and oil tubes shown in Fig. 1.

Fig. 3 is a fragmentary perspective view partly in section, showing details of the radiator shown in Fig. 1.

Fig. 4 is a perspective view of a modified form of radiator made according to the present invention.

In the form shown the arcuate radiator is made up of a number of alternate long and short water tubes 1, 2 and oil tubes 3.

Suitable inlet and outlet header tanks 4, 5, 6, 7

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respectively, are provided, the header tank 4, 5 of the water tubes 1 and 2 being at one end of the arc and the header tanks 6, 7 for the oil tubes 3 at the other. The water tube 1 extends for the full arc right up to the oil header tank 6, 7 but the oil tubes all stop short of the header tanks 4, 5 for the water tubes. In order to fill up the gaps left at the end of each oil tube 3 (shown in the drawing as a solid line to make them more easily distinguishable) and make the most use of the area available complementary arcuate short water tubes 2 are provided each forming a continuation of the corresponding oil tube 3 so as to complete the arc and these shortened water tubes 2, all of which are of different lengths according to the radius of the arc to which it is formed are mounted in the header tanks 4, 5 for the water tubes. In order to keep the header tanks 4, 5 for the water tubes and header tanks 6, 7 for the oil tubes completely separate from one another and to avoid any possibility of leakage taking place from one to the other, the tubes are divided lengthwise into flow and return passages and separate inlet and outlet header tanks are provided though a single header tank could be employed which is divided into inlet and outlet portions suitable couplings for connecting to the flow and return conduits being provided. The details of construction of the radiator shown diagrammatically in Figs. 1 and 2 are to be seen in Fig. 3 and it is to be understood that no novelty is claimed for the bracing of the tubes or the arrangement of flow and return passages within the tubes.

Referring to Fig. 3 it will be seen that the oil tubes 3 all of equal length open above the tube plate 2' whilst the long water tubes 1 are closed at the end adjacent the plate 2'. The plate 2' forms the bottom of the header tanks 6 and 7 for the oil or other viscous fluid. The sheet metal internal and external bracing of the tubes technically termed secondary surfaces follows normal radiator construction, as shown for example in Patent No. 2,376,749 to the present applicant. The external bracing comprises corrugated metal sheets 8 between the tubes and the internal bracing comprises corrugated metal sheets 9, 10 and 11 within the tubes the corrugations being arranged to divide the tube into flow and return passages in the sheets 9 and 10 and transverse communication passages in the sheet 11 which construction is already known. This arrangement is shown clearly in the development shown in Fig. 2.

The corrugated metal sheets and the inner and outer surfaces of the sheets of which the tubes

are formed are coated with solder before assembly and following the usual methods the assembled unit is heated to cause the solder to melt and bond the whole into a single unit as well as sealing the folded seams. The return flow arrangement of the corrugations of the internal secondary surface is seen more clearly in Fig. 2 which shows one of the oil and water tubes each with one side removed. The tubes are all braced internally and held in spaced relation externally by corrugated secondary surfaces the external corrugated secondary surface forming air passages parallel with the axis of the arc.

In the modified construction shown in Fig. 4 the same reference numerals are applied to the same parts and accordingly the operation is the same as with the construction shown in Figs. 1 to 3 and described with reference thereto. It is in fact as though an arcuate radiator such as is shown in Fig. 1 had been pulled out straight thereby assuming a trapezoidal instead of an arcuate form.

It must be understood that the present invention does not only refer to radiators of arcuate, circular or trapezoidal shape but may also be applied to radiators of any shape in which some of the tubes have to be of varying length to occupy the available space.

With a heat exchange apparatus made as described above a more efficient cooler for oil or other viscous fluid is obtained than with constructions having tubes of varying length and it has been found that with the non-viscous fluid such as water the varying lengths of the tubes does not have any apparent detrimental effect on the efficiency. The construction further is inexpensive and simple and makes the greatest use of the available space.

What I claim and desire to secure by Letters Patent is:

1. Heat exchange apparatus comprising an assembly having inlet and exit header means for relatively viscous fluid at one end thereof and inlet and exit header means for less viscous fluid at the other end thereof, the distance of the assembly from end to end between opposite header means being less at one side of the same than at the other, a first set of tubes shorter than said lesser distance for the relatively viscous fluid extending lengthwise of the assembly parallel to each other some of the distance between said inlet and exit header means and connected at one end to said first named inlet and exit header means, said tubes being closed at their ends remote from said first named inlet and exit header means and being divided internally into flow and return passages, and being all of the same length, and a second set of similarly formed tubes all of different lengths for the less viscous fluid, extending lengthwise of the assembly parallel to each other, from said less viscous inlet and exit header means approximately to the closed ends of said first named tubes and a third set of similarly formed tubes also for the less viscous fluid extending lengthwise of the assembly from said less viscous inlet and exit header means between the tubes of said second set and for the latter part of their extent between the tubes of said first set approximately to said opposite header means.

2. Heat exchange apparatus comprising an assembly of arcuate shape having inlet and exit header means for relatively viscous fluid at one end thereof and inlet and exit header means for less viscous fluid at the other end thereof, a first set of arcuate tubes for the relatively viscous fluid extending parallel some of the distance to each other between said inlet and exit header means, from and connected at one end to said first named inlet and exit header means, said tubes being closed at their ends remote from said first named header means and being divided internally into flow and return passages, and being all of the same length, a second set of similarly formed arcuate tubes for the less viscous fluid extending parallel to each other from said less viscous inlet and exit header means approximately to the closed ends of said first named tubes, and a third set of similarly formed arcuate tubes for the less viscous fluid extending lengthwise of the assembly from said less viscous inlet and exit header means between the tubes of said second set and for the latter part of their extent towards the opposite header means between the tubes of said first set.

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The following references are of record in the file of this patent:

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