Feb. 3, 1953 S. PRZYBOROWSKI 2,627,283

HEAT EXCHANGE CONDUIT FOR OIL COOLERS

Filed Nov. 27, 1950 2 SHEETS—SHEET 1

Fig. 1.

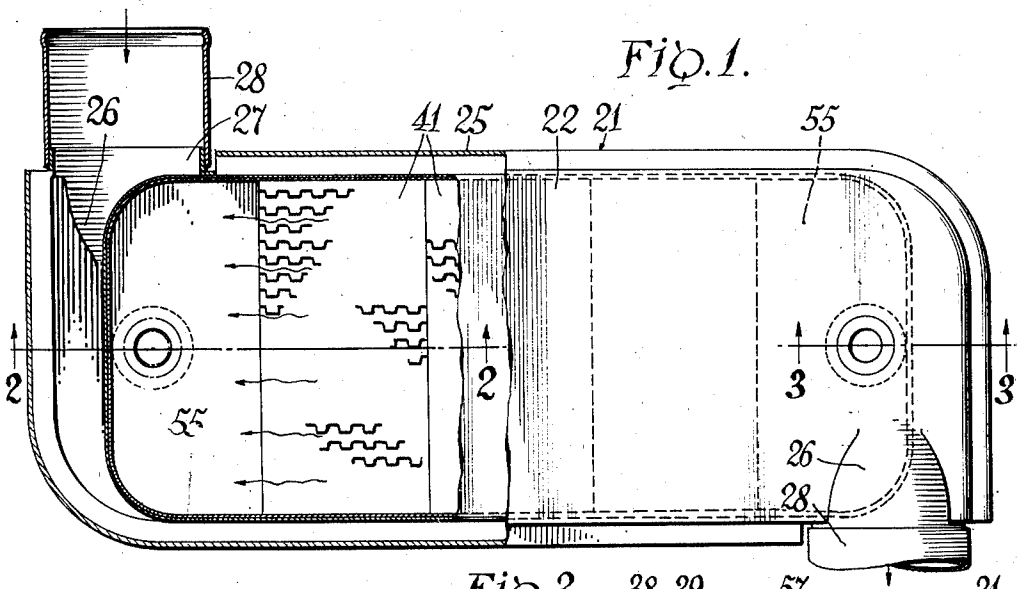


Fig. 3.

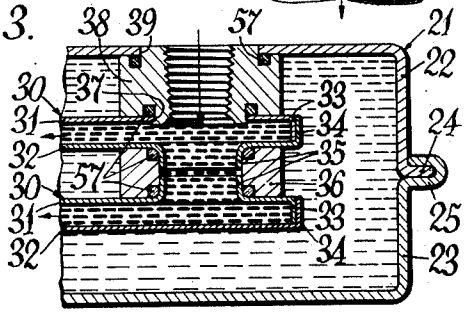


Fig. 2.

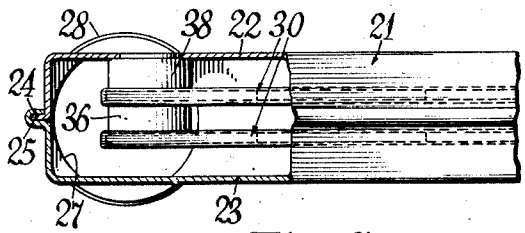


Fig. 5.

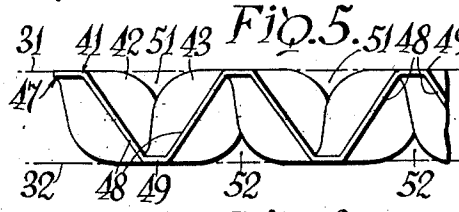


Fig. 6.

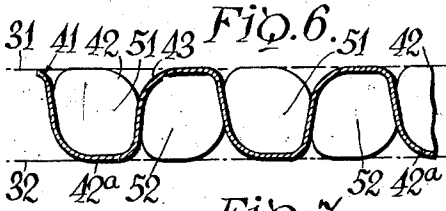


Fig. 7.

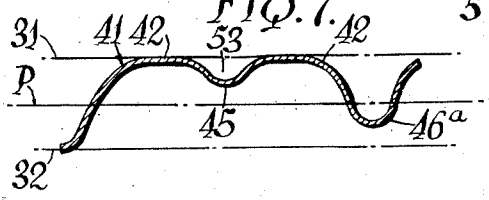
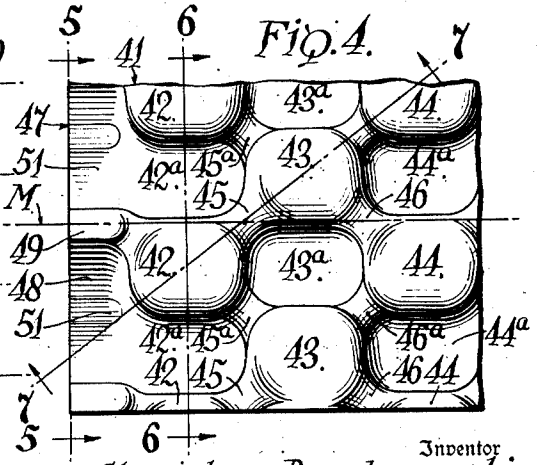


Fig. 4.



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Fig. 8.

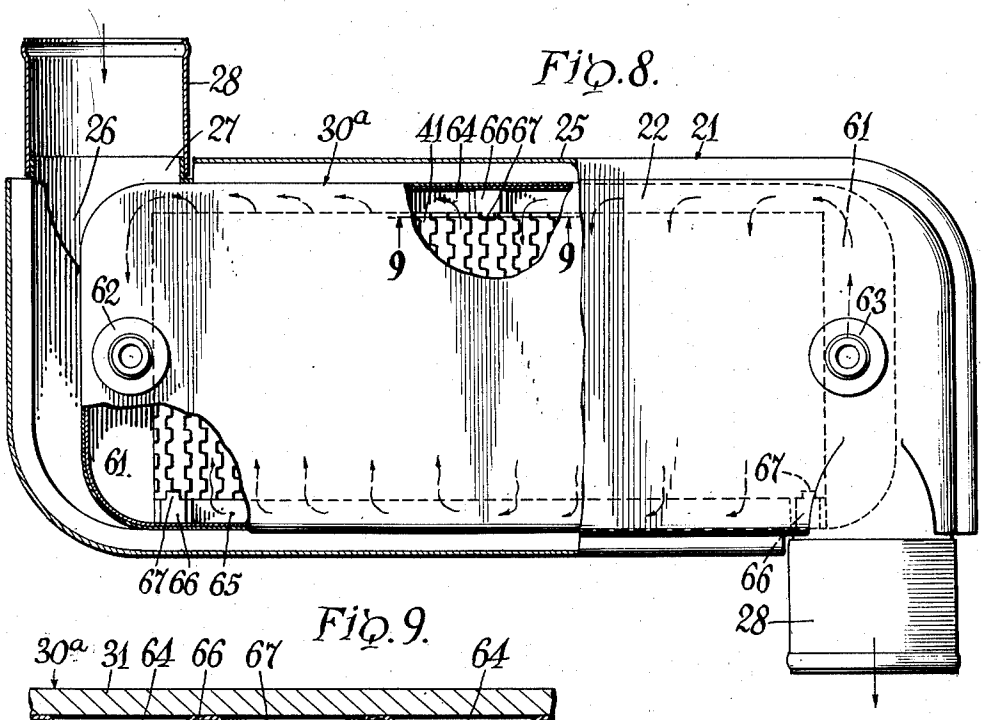


Fig. 9.

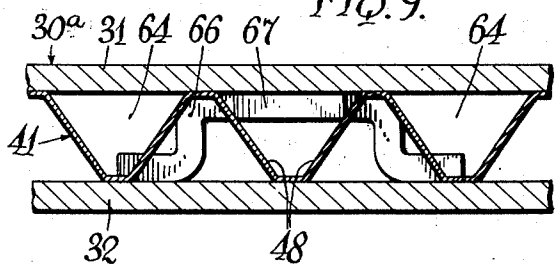


Fig. 10.

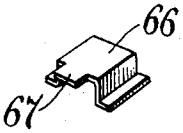
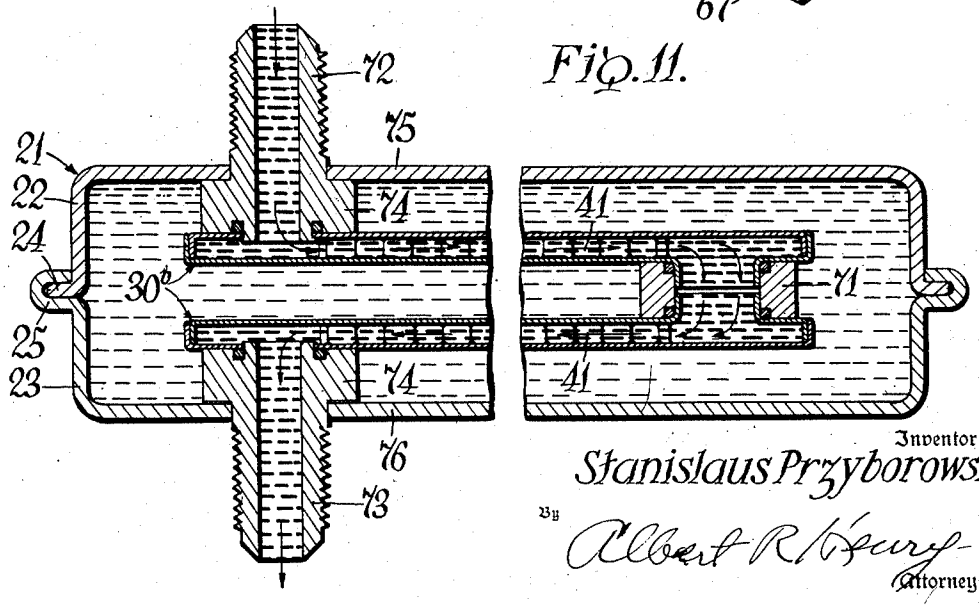


Fig. 11.



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UNITED STATES PATENT OFFICE

2,627,283

HEAT EXCHANGE CONDUIT FOR OIL COOLERS

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Application November 27, 1950, Serial No. 197,680

4 Claims. (Cl. 138—38)

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This invention relates to a heat exchange conduit particularly adapted for use in cooling apparatus for oil in automatic transmissions, although the invention may be applied to other heat transfer problems, and wherein it is desired to effect a heat exchange between two confined fluids, or between one confined and one unconfined fluid.

Oil coolers have heretofore been proposed to cool the lubricating oil of internal combustion engines and compressors, and have generally contemplated the withdrawal of the oil from the crankcase for circulation through an external heat interchanger. Another problem relating to oil cooling arises in connection with hydraulic power transmissions, such as are intended for use with automotive power plants, and wherein the heat developed by the circulation or agitation of the hydraulic fluid sufficiently increases its temperature as to require extraneous cooling. Many types of crankcase oil coolers are unsuited for this service. Transmission oil is of different viscosity, the temperature ranges are not the same, and problems of space and flow resistance make relatively bulky coolers, and long connecting lines, practically unsatisfactory.

It is well understood that when the oil is cold, and is therefore at a relatively high viscosity, its flow through a cooler is lowered, and it tends to exert abnormal pressures on the walls of the flow passages. Proposals have heretofore been advanced to by-pass the main heat exchange passages of the cooler until the oil becomes warm, with its viscosity correspondingly reduced, so that it may flow through the main passages at lower pressure and with appreciable velocity. The incorporation of by-pass valves and passageways on a cooler adapted for use with hydraulic transmissions, however, adds greatly to the cost, presents another service problem, and interferes with arranging the cooler satisfactorily in the confined space available for it.

The present invention provides a solution for these difficulties by providing an oil cooler or heat exchange unit which is compact, may be made without incorporation of movable by-pass valves, and wherein the oil is made to flow through a plurality of channels or passageways with high turbulence and low frictional resistance, and wherein the oil may automatically by-pass itself from one channel to another in response to localized high internal pressures or pressure differentials. Typical practical embodiments of the invention, which have been found to be highly

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efficient in service, are illustrated in the accompanying drawing, wherein:

Fig. 1 is a plan, with portions broken away, of one form of oil cooler;

Fig. 2 is a fragmentary view taken substantially along the line 2—2 of Fig. 1, further illustrating the cooler;

Fig. 3 is an enlarged fragmentary section taken on the line 3—3 of Fig. 1;

Fig. 4 is a fragmentary enlarged plan of the internal oil distributing element of the cooler;

Figs. 5, 6, and 7 are additional views of the distributing element, taken substantially on the correspondingly numbered lines of Fig. 4;

Fig. 8 is a view similar to Fig. 1 of another form of the invention, providing a different oil flow path;

Fig. 9 is an enlarged view on the line 9—9 of Fig. 8, particularly showing a baffle member;

Fig. 10 is a perspective of the baffle member of Figs. 8 and 9; and

Fig. 11 is a section through another form of oil cooler.

The oil cooler shown in Fig. 1, and also in Fig. 8, comprises an external main casing 21 formed of two stamped rectangular pan-like halves 22 and 23. The part 22 is formed with a flange 24, while the part 23 is formed with a longer flange 25 which is adapted, upon final assembly, to be rolled over the flange 24 to provide a lock joint. Each part is formed at diagonally opposite corners with similar belled embossments 26 which align in pairs to form inlet or outlet openings 27. To these may be attached fittings 28, which in turn may be connected to tubes, not shown, for admitting coolant to the oil cooler. Specifically, it is contemplated that the casing 21 will be connected to the engine cooling liquid circuit, so that the casing will be flooded with circulating water or other liquid coolant when in use, as indicated by the conventional broken light lines in Fig. 3.

Within the casing 21 are one or more oil receiving and distributing heat exchange conduits, generally designated by the reference numeral 30. Two are shown in Figs. 2 and 3, but it should be understood that a light duty cooler may require only one conduit, while a heavy duty type, or one operating with relatively high temperature coolant, may require several. Each unit 30 comprises a pair of shallow pan-like rectangular plates 31 and 32, formed with telescoping flanges 33 and 34 so that, when the plates are superimposed, they form a confined conduit or passageway. When more than one unit 30 is to be employed,

the plates 31 and 32 are formed at each end with externally projecting cylindrical flanges 35 which align with each other upon assembly, and which nest within the apertures of spacing and supporting collars 36. One plate 31 or 32 is also formed at each end with apertures 37 adapted to be aligned with spacing and supporting collars 38 which fit into openings 39 formed in the casing portion 22.

The collars 38 are drilled and tapped to receive connectors, not shown, by means of which the oil to be cooled may enter the conduits 30 at one end and flow to discharge through the companion collar at the opposite end. In the arrangement shown in Figs. 1 to 3, it will be apparent that the oil flows in parallel paths through the two units 30, the entering oil dividing itself through the aperture formed by the flanged portions 35 and collars 36.

Each conduit 30 is internally provided with a heat transfer and distributing plate 41, indicated more or less schematically in Fig. 1, and shown in detail in Figs. 4 to 7. The plate 41 is formed from sheet metal stock by means of dies which press bumps 42, 43, 44, and other bumps 42*a*, 43*a*, and 44*a*, into the sheet in opposite directions from the original plane of the sheet, which is indicated by the broken line P in Fig. 7. It will be noted that the bumps 42, 43, and 44 are arranged in rows, and that they lie above and below, as viewed in Fig. 4, of a median line M drawn through the bumps of each row. Stated otherwise, the bumps 42, 43, 44 form a series of staggered and somewhat sinusoidal spaced rows.

It will also be seen that the bumps 42, 43, 44 are spaced from each other, but are interconnected by other smaller bumps 45, 46, of less elevation than the larger bumps 42, 43, 44. To differentiate between these bumps, the large ones may be termed primary bumps, and the smaller ones designated as secondary bumps. As viewed in Fig. 4, the bumps 42, 43, 44, 45 and 46 appear to be elevated above the plane of the paper. If a specimen made in accordance with the figure is turned over, then the bumps 42*a*—46*a* would appear elevated, and the first noted bumps would be depressed. All of the bumps are generally smooth or moundlike, although the primary bumps have appreciable surface area on their tops, as will be apparent from Figs. 5 and 6. The edges of the die pressed sheet are formed with corrugated marginal portions 47 delimited by comparatively straight sides 48 and flat crests 49, which crests are disposed substantially in the reference median lines M of the several rows of primary bumps.

As shown by the broken lines 31 and 32 in Figs. 5, 6, and 7, the primary bumps 42, 42*a*, etc. abut the inner faces of the casing 21. The various rows of bumps, with the walls of the portions 31 and 32, thus define a plurality of channels 51, 52, of tortuous or sinusoidal configuration, through which the oil may flow. It will also be seen that the secondary or connecting bumps 45, 46, 45*a*, 46*a*, do not contact the walls of the casing portions 31 and 32, but are slightly spaced therefrom to provide pressure relief ports 53. Under some operating conditions, the viscosity of the oil may be such as to create localized and vagrant pressure differentials between the channels. Such pressures force some of the oil into adjacent channels, thus rapidly equalizing the pressures throughout the various channels to relieve undue stress and add to the uniformity of heat transfer.

As best shown in Figs. 1 and 3, the distributing plates 41 are cut from the formed stock and disposed transversely of the plates 31 and 32 between the inner margins thereof. They are sufficiently spaced from the inlet and outlet fittings to form an uninterrupted zone 55 at each end of the conduit, providing a distributing or collecting reservoir for the various channels. The oil may therefore flow lengthwise of the conduit 30, in a plurality of generally confined paths, but from which it may escape in part into other channels, as previously explained. The high ratio of internal surface in contact with the oil, to the external surface in contact with the coolant flowing around the conduits 30, and the substantial amount of direct contact between the crests of the bumps and the walls of the conduit sections 31 and 32, thus assure an efficient heat transfer. These attributes are, of course, coordinated with the nature of the channels 51, 52, whose smooth walls reduce friction, and whose sinusoidal form imparts desirable turbulence.

To assemble the cooler, a sheet of brazing metal is laid in the casing section 32 to cover its entire internal area, the plate pieces 41 are laid on the sheet, and are covered by another sheet. The mating casing section 31 is then applied, and the unit is then assembled with the collars 36 and 38. These may be provided with annular grooves, as shown in Fig. 3, to receive rings 57 of brazing material. The subassembly is then oven baked to bond the parts together at their regions of contact. Thereafter, the subassembly of conduits 30 is assembled with the casing sections 22 and 23, the flanges 24 and 25 are coated with brazing metal, and the joint between them is formed. The assembly is then baked, with the collar 38 facing down, so that the ring 57 may flow into the joint made with the aperture 39. A properly assembled and baked unit should withstand test pressures of one hundred pounds per square inch without leakage or deformation, which, considering that fairly thin stock is used, indicates the high measure of strength and ruggedness of the conduit.

The modification shown in Figs. 8, 9, and 10 employs the same external casing 21, sections 31, 32, and collars 36 and 38, which therefore need not again be described. The main difference is in the arrangement of the plate 41 within the conduits 30*a*. It will be seen that these are positioned with their channels disposed transversely, rather than longitudinally, as was explained in connection with Fig. 1. The plates 41 are spaced from the ends of the conduit, to provide reservoirs 61 around the inlet and outlet fittings 62 and 63, which are herein shown as external nipples brazed to the outer surface of the casing 21. The plates are also spaced from the side walls of the portions 31 and 32, to provide ducts 64 and 65.

Small stop blocks or baffles 66, of channel shaped section, as shown in Fig. 10, are inserted at each end of the duct 65, and midway of the duct 64. These are formed with projecting tabs 67 on their webs, which enter the space between adjacent marginal sides 48 to retain the plate 41 in proper alignment, and to aid in blocking flow past the baffles. Assuming arbitrarily that the nipple 63 is the inlet fitting, it will be seen that the baffle 66 at the lower right of Fig. 8 prevents direct flow into the duct 65. The path of the oil is into duct 64 until it encounters the upper baffle 66, transversely through the plate portion

41 to the duct 65, and then in a reverse direction through the plate 41 to the left hand portion of the duct 64, and thence into the outlet fitting 62. This arrangement increases the total length of the flow path through the conduit without excessive increase in pressure drop, and thus increases the temperature reduction of the oil between inlet and outlet.

The embodiment shown in Fig. 11 shows how conduits 30b may be connected for straight series flow, as distinguished from parallel flow presented in Fig. 1. The conduits 30b are interconnected at one end by collars 71, and are equipped with like inlet and outlet fittings 72 and 73 at their opposite ends, which have collar portions 74 to abut the walls of external casing sections 75 and 76. The distributing plate 41 is laid in the conduits longitudinally, as described in connection with Fig. 1. The sections 75 and 76 are, of course, formed with suitable water inlet and outlet openings, which it is deemed unnecessary to illustrate to explain the oil circuit. This arrangement further increases the length of the flow path through the cooler.

It will be obvious that the outer casings could be removed in each of the embodiments, and cooling effected by air or other unconfined fluid, and that external fins could be applied to the various heat exchange conduits, if so desired. It will also be understood that it is intended to afford to the invention a scope commensurate with that encompassed by the following claims.

I claim:

1. A heat transfer conduit comprising flat spaced wall members forming a confined passageway and a distributing plate interposed between said wall members, said distributing plate being formed with spaced rows of spaced primary bumps which are alternately offset to either side of a median line through said rows, thereby to form tortuous channels between said rows, the height of said bumps being such as to engage the inner surfaces of said wall members, the bumps of each row being interconnected by and merging into each other through secondary bumps of less height than the primary bumps and which are slightly spaced from the inner surfaces of said wall members, thereby providing gaps through which liquid flowing through said channels may distribute itself transversely from one row to another.

2. A heat transfer conduit as set forth in claim 1, wherein the spaced wall members are formed with liquid inlet and outlet openings at opposite ends of the conduit, and the distributing plate is slightly spaced from said openings to provide distributing and collecting reservoirs.

3. A heat transfer conduit comprising substantially rectilinear spaced wall members formed with inlet and outlet openings at opposite ends of the conduit, a distributing plate interposed between the wall members and spaced from the edges thereof thereby to provide open ducts on opposite sides of the conduit, said plate being formed with rows of alternately offset primary bumps of such height as to contact the wall members, thereby to provide tortuous channels between the rows, said channels being positioned transversely of the conduit to provide a plurality of flow passages between the ducts, and baffles positioned in the ducts in alternate relation to each other, thereby to cause fluid flowing through the conduit from the inlet to the outlet opening to flow transversely and in first one direction and then the other.

4. A heat transfer conduit as set forth in claim 3, wherein the baffles are formed as small blocks fitting snugly between the edges of the conduit and the distributing plate, and with projecting tabs partially entering the adjacent channel of the plate.

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REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
785,580	Shiels et al.	Mar. 21, 1905
1,987,604	Corbett	Jan. 15, 1935
2,131,929	Amme	Oct. 4, 1938
2,281,754	Dalzell	May 5, 1942