

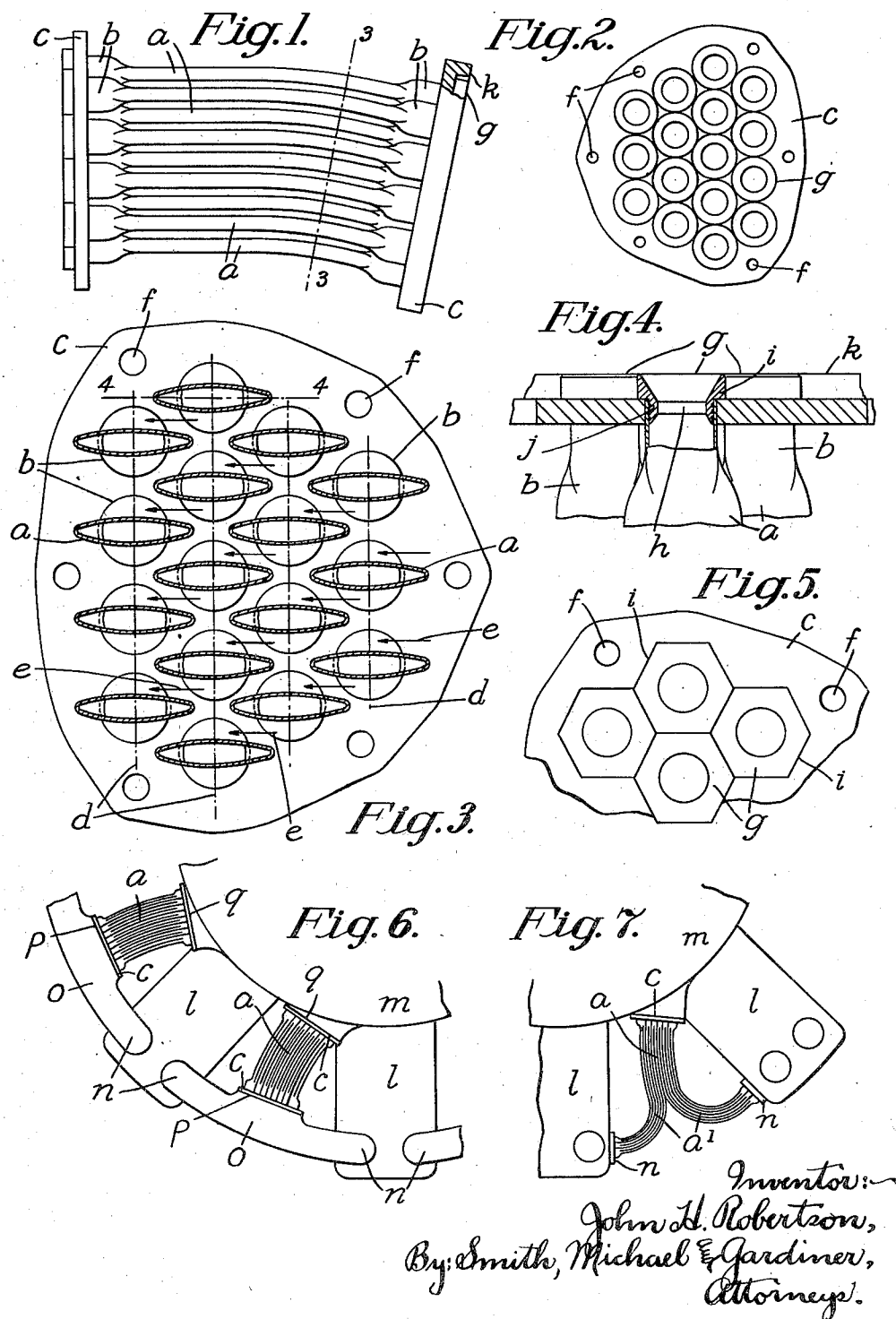
Jan. 11, 1938.

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2,105,267

CHARGE COOLER

Filed Feb. 26, 1936



UNITED STATES PATENT OFFICE

2,105,267

CHARGE COOLER

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Application February 26, 1936, Serial No. 65,899
In Great Britain March 13, 1935

1 Claim. (Cl. 257—248)

This invention relates to coolers for the air or mixture charges admitted to the cylinders of internal combustion engines.

The invention has for its main object to provide an improved arrangement of cooler which is particularly applicable to aircraft engines of the radial cylinder type having forced induction by means of a blower or supercharger driven by the engine.

According to this invention, the cooler comprises a nest of tubes which for the greater part of their length are of flattened oval or stream-line section, the ends of the tubes being of circular section and secured in the tube-plates by means of nipples located inside the ends of the tubes.

The invention is hereafter described with reference to the accompanying drawing, in which:—

Fig. 1 is a front elevation of the cooler.

Fig. 2 is an end view seen from the left of Fig. 1.

Fig. 3 is an enlarged view in section on the line 3—3 of Fig. 1.

Fig. 4 is a section on the line 4—4 of Fig. 3.

Fig. 5 is a plan of Fig. 4, showing the use of hexagonal nipples.

Figs. 6 and 7 are diagrams showing the application of coolers of two different forms to radial cylinder engines.

Referring to Figs. 1 to 3, the cooler comprises a nest of tubes *a* having their opposite ends *b* secured into tube plates *c*, which are shown in Fig. 1 as being inclined to one another, for example at an angle of $11\frac{1}{2}$ degrees, the tubes *a* being curved to a corresponding extent and being of different lengths to suit the space between the tube plates. For the greater part of their length, the tubes *a* are of flattened oval or stream-line section as seen in Figs. 1 and 3, the ends *b* being maintained of circular section; the curvature of the tubes may conveniently be restricted to the stream-line portions, leaving the ends *b* cylindrical.

The tubes *a* are preferably arranged in parallel rows, indicated by the vertical lines *d* in Fig. 3, the tubes of each row being staggered in relation to the tubes of the adjacent row or rows, and the flattened or stream-line section lying in the direction of the cooling air current, indicated by the arrows *e* in the same figure. For example, there may be sixteen tubes in each cooler, arranged in rows of four, five, four and three tubes respectively, the tube-plates *c* (see Fig. 2) being of shape corresponding to the circumscribing polygon, with the necessary margin

for the provision of the bolt holes *f* to be used in mounting the cooler; the inclination of the plates *c* to one another, given for example as $11\frac{1}{2}$ degrees, will depend upon the arrangement of the parts to which the cooler is to be attached.

As best shown in Fig. 4, the tube-ends *b* are secured to the tube plates *c* by means of nipples *g* of the type having internal beadings or thickened portions *h* which are expanded radially outwards in order to form tight joints between the tubes and the tube plates. The nipples, made of ductile metal, are preferably flanged at their outer ends, these flanges *i* abutting against the tube plates, and being chamfered internally at both ends to facilitate the flow of the charge through the tubes; their barrels which enter the tubes are shown provided with circumferential ribs and grooves which form separate annular spaces *j* so as to localize the expansive forces applied radially outwards towards the inner walls of the tubes, thus leading to a concentration of stress and producing fluid tight joints according to my pending patent application Serial No. 60,539, executed on January 10, 1936.

One of the tube-plates *c*, viz. that at the right hand side of Fig. 1, is shown provided with a rim *k* of greater thickness than the middle portion into which the tube-ends *b* are secured, the nipple-flanges *i* being thus accommodated within a recessed area inside the rim *k* so as to leave a flush jointing surface; two or more separate recesses may obviously be provided by running one or more ribs across the face of the plate between the rim-fitted edges. Alternatively, as shown in Fig. 5, the nipple-flanges *i* may be of hexagonal shape, so that they fit together to form a flush surface suitable for making the joint; in this case the rim *k* around the tube plate may be suppressed.

The provision of a flush jointing surface at one end of the cooler, in conjunction with the relative inclination of the two tube plates *c*, facilitates the fitting and removal of the cooler without it being necessary to disturb the joints of the induction manifold or T-pipe, or the expansion joint usually provided at the junction with the compressor casing.

Fig. 6 illustrates the arrangement of the cooler shown in Figs. 1 to 3, applied to a radial cylinder engine, of which two cylinders *l* are illustrated projecting beyond the casing *m* which encloses the supercharger; each cylinder is shown provided with two induction ports *n*, adjacent cylinder ports being connected by a T-pipe *o* with a central branch *p* into which the charge is fed for

both cylinders. The cooler has one tube plate *c* connected to this branch *p*, and the other header (preferably that having the flush jointing surface) is connected to a facing *q* at the outlet from the blower casing; this facing is assumed to be oblique relatively to the tangent to the casing at a point midway between the cylinders *l*, the angle of such obliquity being for example $11\frac{1}{2}$ degrees to agree with the inclination of the two tube plates *c*. It will be noted that the cooler is located in the interval between the cylinders *l* and thus freely exposed to the air currents. If desired a separate cooler may be provided for each cylinder, the outer end of the cooler being connected to the induction port or ports of the one cylinder. Alternatively the several T-pipes *o* may be replaced by a continuous pipe forming a ring-main, into which the individual coolers deliver at evenly spaced points, one cooler being preferably arranged between each pair of adjacent cylinders. This continuous ring-main constitutes a reservoir for the accumulation of the charge of air or mixture, smoothing out the distribution of charge to the several cylinders.

Fig. 7 illustrates a modification, in which the cooler has its tubes *a* all secured at one end to a single tube plate *c*, but diverging into two clusters *a*¹, each connected to the induction port *n* of a separate cylinder *l*; if the cylinders are each pro-

vided with two induction ports, as shown, similar coolers may be fitted in all the intervals between the cylinders, each cylinder then drawing its charge through the adjacent clusters or halves of the two coolers on either side of it.

The cooler may evidently be applied in various other ways according to the particular type of engine to which it is to be fitted, and according to the location of the blower or equivalent.

The tubes and tube plates employed for making the cooler, as well as the nipples for jointing the ends of the tubes, are conveniently made of light alloys of aluminium, magnesium or like metals.

What I claim is:—

A cooler comprising a plurality of tubes having ends of circular cross section, two flat tube plates perforated to receive said tube ends, and expanded nipples securing said tube ends in the perforations of said tube plates, said nipples at one end of the cooler including hexagonal flanges abutting against the outer face of the tube plate, said hexagonal flanges fitting together to form a flush jointing surface, the portions of said tubes intermediate between said ends being formed to stream line section, and all of said tubes having the axes of said stream-line intermediate portions parallel to each other.

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