C. DAY & G. E. WINDELER.

INTERCOOLER FOR AIR COMPRESSORS.

APPLICATION FILED JUNE 13, 1912.

1,201,705. Patented Oct. 17, 1916.

FIG 1.

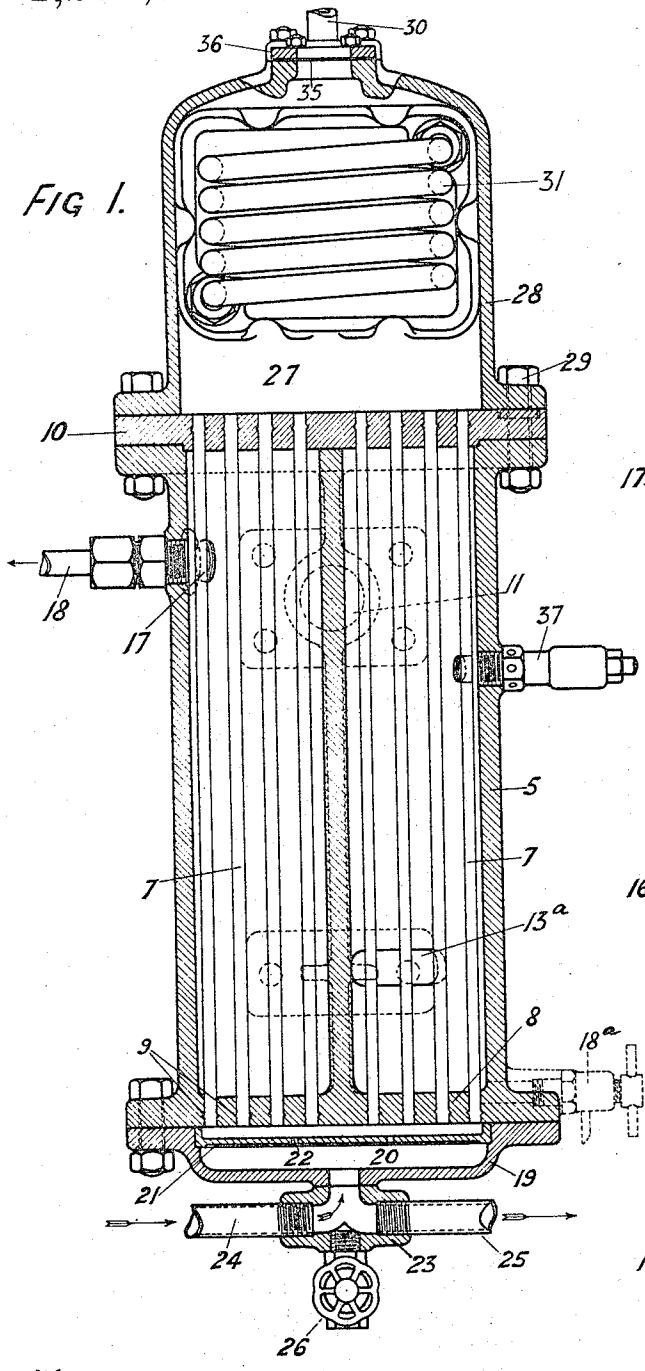
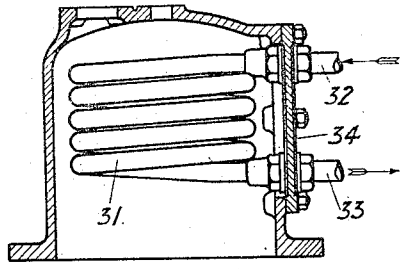


FIG 2.



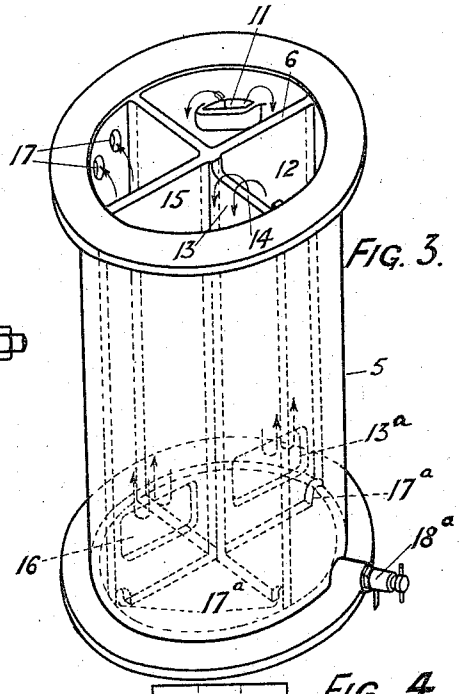
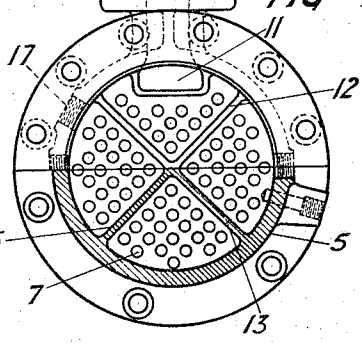


FIG. 3.

FIG 4.



WITNESSES:

Marcus L. Byng.

J. Ellis Glen

INVENTORS:

CHARLES DAY

GEORGE E. WINDELER.

BY Albert G. Davis

ATTORNEY.

UNITED STATES PATENT OFFICE.

CHARLES DAY AND GEORGE E. WINDELER, OF STOCKPORT, ENGLAND, ASSIGNORS TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

INTERCOOLER FOR AIR-COMPRESSORS.

1,201,705. Specification of Letters Patent. Patented Oct. 17, 1916.

Application filed June 13, 1912. Serial No. 703,391.

To all whom it may concern:

Be it known that we, CHARLES DAY and GEORGE E. WINDELER, subjects of the King of Great Britain, and residing at Stockport, county of Cheshire, England, have invented certain new and useful Improvements in Intercoolers for Air-Compressors, of which the following is a specification.

The present invention relates to intercoolers which are more specially intended for use in connection with multi-stage reciprocating air compressors that supply high pressure air to the fuel injectors or pulverizers and starting valves of high compression internal combustion oil engines.

The object of our invention is to improve the construction and operation of such intercoolers whereby the maximum cooling effect may be obtained with a structure of relatively small size, and of simple, cheap and reliable construction.

In the accompanying drawing, which illustrates one of the embodiments of our invention, Figure 1 is a vertical longitudinal section of an intercooler; Fig. 2 is a detail sectional view of the high pressure coil and its inclosing casing; Fig. 3 is a perspective view of the main casing of the intercooler showing the means for directing the air, and Fig. 4 is a plan view, partly in section, of said main casing.

Referring to the drawing, 5 indicates the main cylindrical casing which is provided with internal radial partitions that extend lengthwise and divide the interior thereof into a plurality of chambers through which the air to be cooled passes in series. In the present embodiment of our invention four of these chambers are provided which are substantially equal in size. The number of these chambers can be varied as desired care being taken not to make them too small as this would result in undue friction or opposition to the passage of air, or too large as this would result in a decrease in the cooling effect. The partitions are cast jointed to the cylinder wall and to each other to avoid joints and machine work. Each of the segmental chambers thus formed contains a plurality of thin tubes 7 which are made of some good heat-conducting metal such as brass. The lower ends of the tubes are seated in the bottom integral wall or base 8 of the casing. The holes that receive the ends of the tubes have V-shaped grooves 9 formed therein, into which the metal forming the tube is forced by a suitable tool. The object of this arrangement is to make an air-tight joint. The upper ends of the tubes are similarly arranged, except that they are mounted in a removable plate 10 instead of a fixed part of the casing. This plate is carefully machined and fitted to the casing and also to the ends of the partitions, to form air-tight joints, and is held by bolts as will appear later. As the air is under relatively high pressure, suitable precautions must be taken to prevent its escape.

Referring to Fig. 3, from which the tubes have been omitted for the purpose of illustration, heated air under considerable pressure is admitted to the casing from the first stage of the air compressor by the inlet 11. This inlet opens upwardly so that the entering air strikes the top plates 10, Fig. 1, and is deflected downwardly as indicated by the arrows. The lower end of the partition 12 is provided with a rectangular opening or port 13ª near its lower end, through which air under pressure passes from the first to the second segmental chamber as indicated by the dotted arrows. The upper end of partition 13 is cut away to form an opening or port 14, and permits air to enter the third segmental chamber. The lower end of partition 15 is provided with a rectangular opening or port 16 shown in dotted lines, through which air enters the fourth, and, in this case, the last segmental chamber. Air is discharged from the casing by the orifices or ports 17 that may be connected to the same or different pipes 18, leading to the suction valve or valves of a higher stage of the compressor. As will appear later, the cooling water continuously flows through the tubes in the chambers from the bottom to the top. As a result of this, it will be seen that the air to be cooled in two of the chambers, the first and third, flows in the opposite direction to the cooling water and in the other two chambers, the second and fourth, in the same direction.

In an apparatus of this character a certain amount of water or oil, or both, will be entrained with the air received from the compressor. To prevent it from being carried into the high pressure stage of the com-

pressor, a separator is provided. To this end, the lower openings or ports 13ª and 16, which cause an abrupt turning of the air, are located a suitable distance above the base or bottom plate 8. As a result of this, the particles heavier than air are discharged and collect in what may be termed receptacles in the bottoms of the several chambers. In order that the collection of water and oil may be discharged from the several receptacles, the outer lower corners of the partitions 12, 13 and 15 are cut away as indicated at 17ª. Connected with one of the receptacles is a manually-controlled blow-off cock 18ª, which should be momentarily opened from time to time to permit the water and oil to be discharged.

It will be evident from the above description that the air passes first in one direction, and then in the opposite, resulting in a long and somewhat tortuous passage. The present structure therefore has the great advantage of being short, while, at the same time, large cooling surfaces are presented to the air currents.

The means for circulating cooling water through the tubes 7 will now be described.

To the under side of the casing is bolted a cover 19, of suitable shape to provide a chamber 20 between it and the bottom part 8 of the casing. Extending across this chamber, and held in place by a shoulder on the cover is a baffler or distributer 21, having a plurality of suitably spaced holes 22, through which the cooling water flows. To the under side of the cover is bolted a fitting 23, to which pipes 24 and 25 are connected, the pipe 24 leading from a source of water supply such as a service main, a cooling tower, or the like, and the pipe 25 leading to another inter-cooler or other device. The fitting is also provided with a drain cock 26 by means of which the cooling water can be drawn off. The water passes through the tubes 7 in multiple, and enters the chamber 27 formed in the top cover or bonnet 28. This bonnet is securely held in place by bolts 29, and these same bolts serve to clamp the tube sheet or head 10 in place. Water leaves the chamber 27 by the outlet pipe 30, which may be connected to a cooling tower or other receptacle. Located within the chamber is a coil of pipe 31, to which high pressure air is admitted by the pipe 32 leading from the discharge side of the high pressure stage of the air compressor. The air after being cooled passes by the pipe 33 to a storage tank from which it is supplied to the pulverizer of the engine or to the air starting valve, or both. It will be noted that the connections to the coil 31 are carried by a door 34 which is bolted to the wall of the cover or bonnet 28. The coil and opening covered by the door are of such size that the coil can be inserted and removed through said opening. This facilitates the manufacture of the apparatus and also permits the coil to be readily removed for inspection or repair. Our experience has demonstrated that the coil can advantageously be made of drawn seamless copper tubing.

The coil 31 is placed horizontally with the outlet at the bottom so that any moisture or oil will be conveyed by the air from the coil instead of being trapped therein. It will also be noted that the same water which cools the low pressure air also cools the high pressure air. By this arrangement the apparatus is greatly simplified and the use of many fittings and parts avoided. By using the baffle plate 21 at the bottom all of the tubes are supplied with substantially equal amounts of water so that the circulation is active at all points and pockets or dead spaces are avoided. In other words, the maximum effect of the cooling water is obtained.

The pressure of air in the coil 31 is relatively high, in many cases as high as 950 pounds per square inch. It sometimes happens that these coils will split open after considerable service, due chiefly to erosion caused by the moisture carried along with the air. If the entire bonnet or cover 28 were made solid, this high pressure might result in bursting it. To avoid this danger, a safety device is provided comprising in the present instance a thin diaphragm 35 that is held in place by a ring 36 that is securely bolted in place. This diaphragm should be strong enough to withstand the pressure of the cooling water in the chamber 27, but should let go when the pressure becomes excessive. Practical experience has demonstrated that this diaphragm can advantageously be made of rubber. The casing 5 is also provided with a safety device to prevent it from being subjected to excessive pressure due to any cause. An ordinary pop safety valve 37 will be found to be satisfactory for this purpose.

As before stated the means for cooling both the low and high pressure air are combined in the same casing and the same cooling water acts on both cooling means in succession. By causing the low pressure air to travel from end to end in each segmental chamber in the main casing, the maximum cooling effect will be obtained in a structure of small size. All other parts are simple in construction thereby reducing the cost of manufacture.

In accordance with the provisions of the patent statutes, we have set forth what we believe to represent the best embodiment of our invention; but it is to be understood that the drawing is only illustrative and that our invention can be carried out by other means.

What we claim as new, and desire to se-

cure by Letters Patent of the United States is:—

1. In a device of the character described, the combination of a casing, partitions that divide the interior of the casing into chambers, ports in said partitions connecting the chambers, said ports being located at the upper end of one partition and at the lower end of the next, each port which is located at the lower end of a partition being spaced from the bottom thereof whereby receptacles are formed between the partitions at the lower end of the casing, means for discharging foreign matter from said receptacles, tubes that extend through the chambers, heads for supporting the tubes at their ends, a cover for one end of the casing that forms a chamber, a bonnet for the other end of the casing that contains a chamber, a coil located in the chamber in the bonnet, means for supplying a cooling medium to the chamber in the cover from which it passes through said tubes to the chamber in the bonnet, and means receiving said medium from the chamber in the bonnet.

2. In a device of the character described, the combination of a casing, partitions that divide the casing into chambers, ports in said partitions connecting the chambers, said ports being located at the upper end of one partition and at the lower end of the next, each port which is located at the lower end of a partition being spaced from the bottom thereof whereby receptacles are formed between the partitions at the lower end of the casing, means for discharging foreign matter from said receptacles, tubes that extend through the chambers, means for supporting the tubes, a chambered head for one end of the casing to which a cooling medium is admitted, a baffler in the chamber for distributing said medium to the tubes, a chambered bonnet that receives the said medium from all of the tubes, a coil in the chamber of the bonnet that is cooled by the medium, and means for conveying the cooling medium to the chamber in the head and from the chamber in the bonnet.

3. In a device of the character described, the combination of a casing, partitions arranged at right angles to each other in said casing and dividing the interior of it into chambers, ports in said partitions connecting the chambers, said ports being located at the upper end of one partition and at the lower end of the next, each port which is located at the lower end of a partition being spaced from the bottom thereof whereby receptacles are formed between the partitions at the lower end of the casing, means for discharging foreign matter from said receptacles, tubes that extend through the chambers, heads for supporting the tubes at their ends, a cover for one end of the casing that forms a chamber, a bonnet for the other end of the casing that contains a chamber, a coil located in the chamber in the bonnet, means for supplying a cooling medium to the chamber in the cover from which it passes through said tubes to the chamber in the bonnet, and means receiving said medium from the chamber in the bonnet.

In witness whereof we have hereunto set our hands and seals this 23rd day of May, 1912.

CHARLES DAY. [L. S.]
GEORGE E. WINDELER. [L. S.]

Witnesses:
ALEX. F. MACDONALD,
JOHN D. GILL.