

No. 873,976.

PATENTED DEC. 17, 1907.

O. ZIMMERMANN.

METHOD OF MANUFACTURING TUBE APPARATUS.

APPLICATION FILED JAN. 2, 1906.

2 SHEETS—SHEET 1.

Fig. 1.

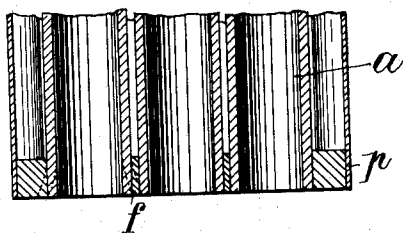


Fig. 2.

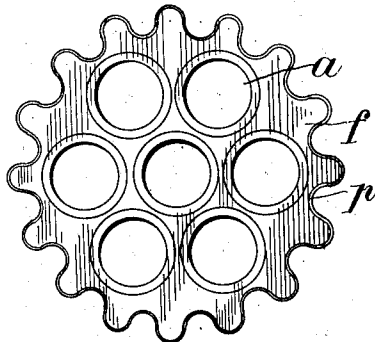


Fig. 3.

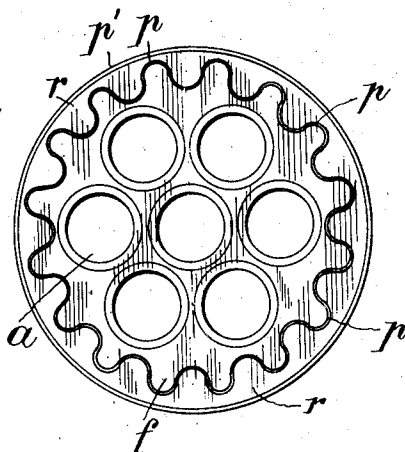
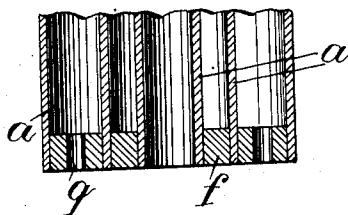


Fig. 4.



Witnesses.

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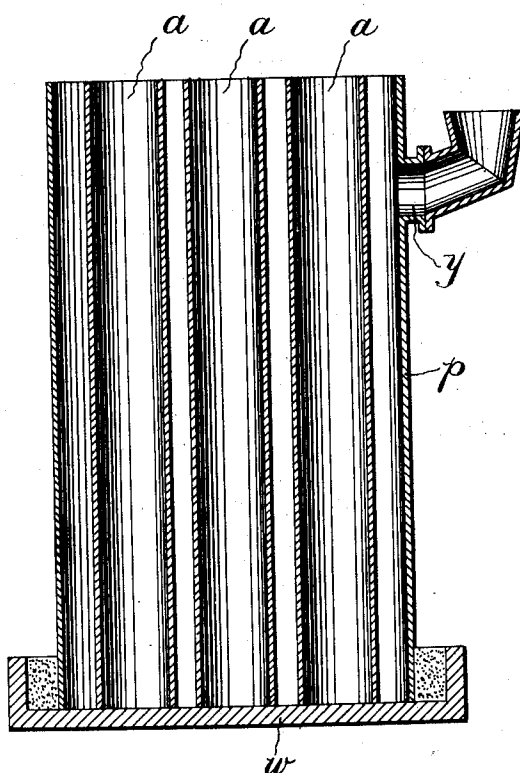
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METHOD OF MANUFACTURING TUBE APPARATUS.

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2 SHEETS—SHEET 2.

Fig. 5.



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OTTO ZIMMERMANN, OF LUDWIGSHAFEN-ON-THE-RHINE, GERMANY.

METHOD OF MANUFACTURING TUBE APPARATUS.

No. 873,976.

Specification of Letters Patent.

Patented Dec. 17, 1907.

Application filed January 2, 1906. Serial No. 294,306.

To all whom it may concern:

Be it known that I, OTTO ZIMMERMANN, a subject of the King of Bavaria, residing at Ludwigshafen-on-the-Rhine, German Empire, have invented certain new and useful Improvements in Methods of Manufacturing Tube Apparatus, of which the following is a full, clear, and exact specification.

My invention relates to the manufacture of tube apparatus and has for its object the method of making such apparatus whereby I am enabled to assemble any desired number of tubes in a flue sheet closer together than by any other method known to me.

To assemble tubes and the like with their mantles or coverings as closely together as possible is a problem that has long been known in this art and so far as I am aware, never before been accomplished. It is impossible to secure tubes close together in their flue sheets by individually inserting the tubes.

Referring to the drawings in which like parts are similarly designated, Figure 1, is a vertical sectional view of a set of tubes set close together and provided with a flue sheet at one end. Fig. 2, is a horizontal section of Fig. 1. Fig. 3, is a transverse section showing a tube set having a corrugated mantle and a cylindrical mantle outside the same. Fig. 4, shows in section, tubes arranged concentrically and their flue sheet. Fig. 5, is a section showing the assembled tubes and casing in the mold ready for having the flue sheet cast thereon.

The assembled set of tubes *a* with their surrounding casing *p* are placed in a mold *w* and the mold being heated during the operation and while the molten metal is being poured through one of the necessary side openings *y* in the casing. The opening is afterwards fitted with a pipe joint for the circulating medium, either steam or water.

When the tubes are very close together I use an open, flat, heated mold as *w* of suitable depth in which the metal, to form the flue sheet, may be melted.

When the metal in the mold has melted the tubes, or when one or more mantles or casings are to surround the tubes, the ends of the tubes and their casings are dipped into a soldering water and immediately put or set into the metal in the open mold. When cooled down the metal will be found to have united to the ends of the tubes and casing and have formed a tube or flue sheet.

In order to prevent the interior of the tube

ends from adhering to the metal in the mold they are coated with graphite or clay, but are left open so that the metal will rise in them and heat the ends of the tubes. This is important where the tubes are placed very close together in order to insure the metal of the flue sheet adhering tightly to the ends of the tube.

Instead of coating the interior of the tubes I insert therein, short sleeves or bushings of iron or steel to prevent the molten metal in the mold from adhering to the interior of the tubes. These sleeves or bushings with the plug of metal that has entered them can readily be knocked out and after melting out the metal plugs are used again, while the melted metal plugs are returned to the mold. I am enabled by this method to make flue sheets of very large diameter, because the molten metal used only rises or travels along the tubes a distance equal to the thickness of the flue sheets, *i. e.* during the insertion of the ends of the tubes into the mold. When casting the metal around the ends of the tubes by pouring it into the mold the metal becomes so rapidly cooled by the hollow tubes that it hardens before it has had time to flow between the tube ends and across the mold, so that only comparatively small tube sets can be provided with flue sheets in this manner.

My method of forming tube sheets permits the use of corrugated metal casings that are cast into the flue sheets with the tubes the undulations or corrugations permitting the equalizing of any possible existing or arising pressures and at the same time give a very much larger heat exchanging surface, thereby increasing the capacity of the apparatus.

The joining of the casings to the corrugated flue sheets could not heretofore be so readily done. The edges of the sheet had to be molded to a shape corresponding to the corrugations in the casing and then soldered to the casing, involving an extraordinary large expense entirely obviated by my method.

I am enabled to assemble one or more casings about the tube set and simultaneously secure them with the tubes to the flue sheet. In Fig. 3, I have shown an inner corrugated casing *p* and a smooth outer casing *p'* about a tube set and cooling water can flow between the two casings at *r* and the steam to be condensed, circulates about the tubes in space *f*

within the corrugated casing *p*. Such arrangements are especially applicable to automobile coolers or radiators where the greatest possible cooling surface, occupying the smallest possible space is very desirable.

In order to render the entrance of air to the tubes more easy, the ends of the tubes are made trumpet shaped as shown by dotted lines in Fig. 1.

10 Instead of corrugated casings, smooth casings may be used and any desired number of tubes may be assembled concentrically as shown in Fig. 4.

Openings *q* may be formed in the flue sheet during the casting by placing cores in the mold in order to provide entrances and exits for the circulating medium into and out of the radiator.

I claim,

20 1. The method of forming tube apparatus which comprises providing a suitable mold in which the flue sheet metal is contained in a molten state, assembling the tubes in their proper relation to one another, protecting the inner surface of the tube ends from adhering to the flue sheet metal and then setting the tubes in molten metal and mold, allowing the flue sheet metal to enter the ends of the tubes and thereby heating the tube ends from the inside as well as the outside and allowing the molten metal to harden about the tube ends.

2. The method of forming tube apparatus which comprises providing a heated mold

containing a suitable molten flue sheet metal, and setting the assembled tubes having the interior of their ends provided with temporary metal bushings, into the molten metal, thereby heating the tube ends both exteriorly and interiorly, allowing the molten metal to harden, removing the tubes and flue sheet from the mold and forcing out the metal bushings with their containing plug of flue sheet metal.

3. The method of forming tube apparatus which consists in assembling the tubes of a set with their casing in proper relation to one another, coating their end surfaces to which the flue sheet is to adhere with a soldering water and providing the interior of the tube ends with a bushing and the surfaces of the ends of the casing that are not to be connected to the flue sheet with a substance preventing the adhesion of metal, providing a mold containing the fluid metal for the flue sheet, setting the ends of the tubes and casing therein and allowing the molten metal to cool and finally knocking out the bushings with the metal that has hardened in them, substantially as described.

In witness whereof, I have hereunto signed my name in the presence of two subscribing witnesses.

OTTO ZIMMERMANN.

Witnesses:

CARL ADOLPH HOBISREITING,
VALENTIN MÜLLER.