Nov. 4, 1930. C. SONNEBORN 1,780,319

DEFORMED TUBE RADIATOR

Filed Dec. 17, 1926 2 Sheets-Sheet 1

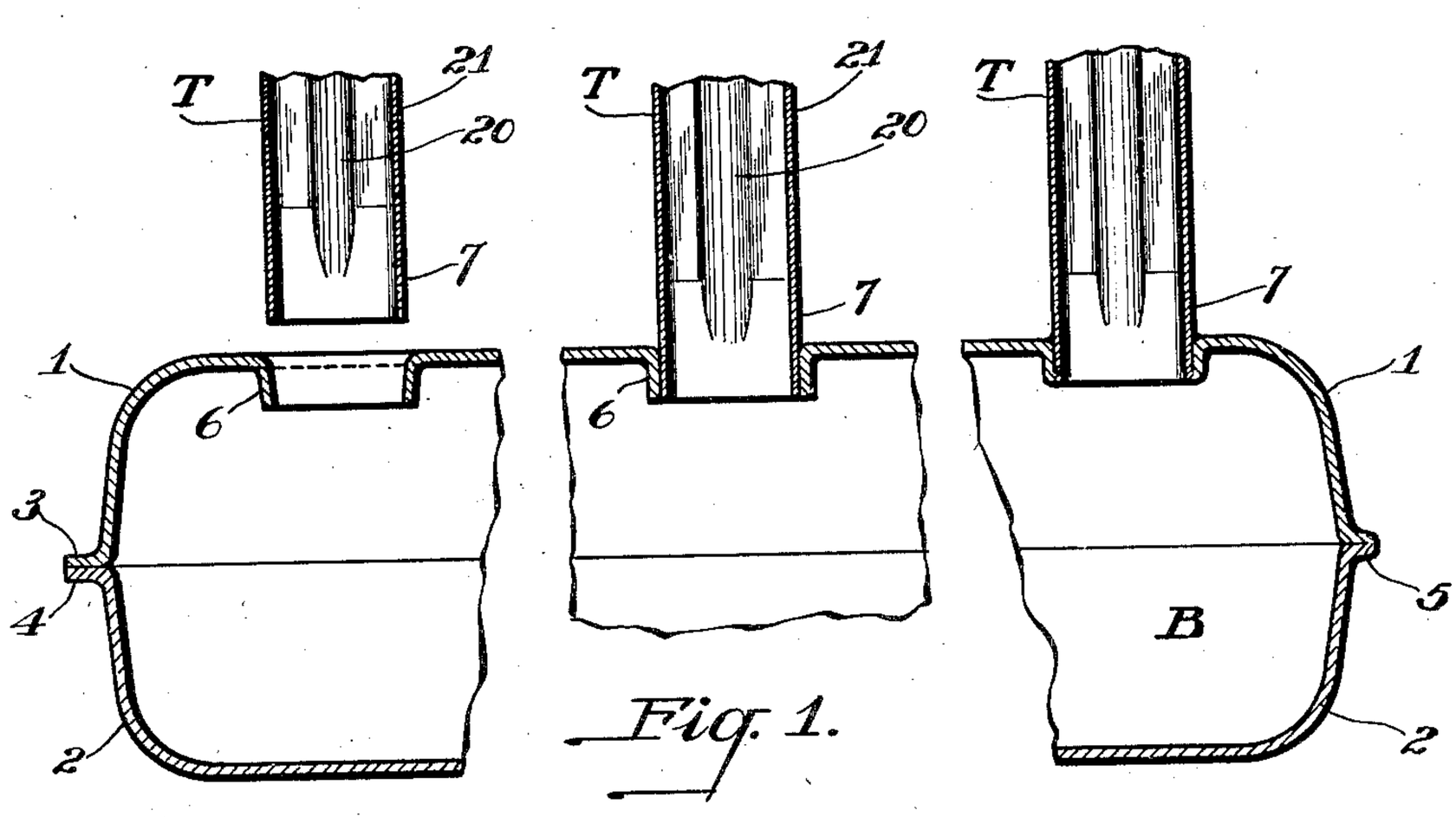


Fig. 1.

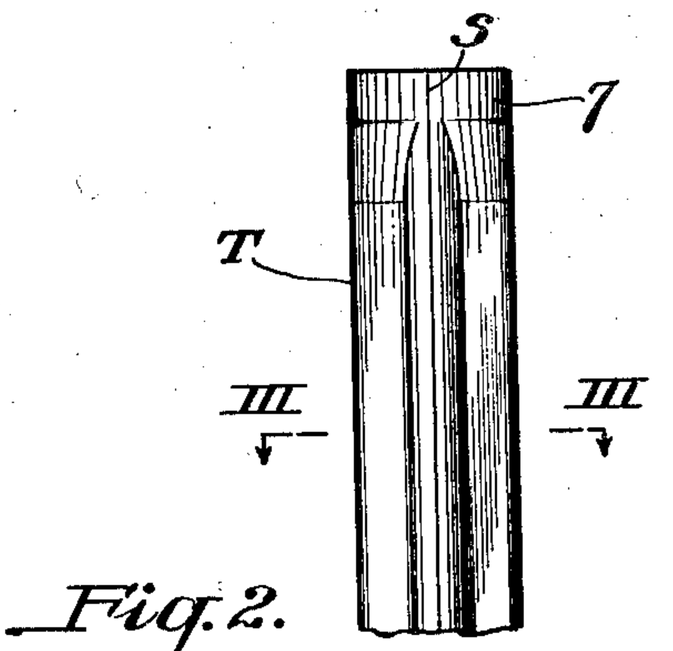
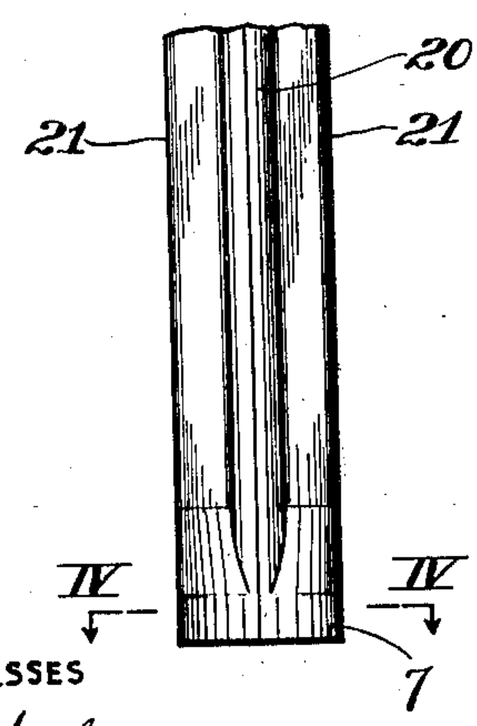


Fig. 2.



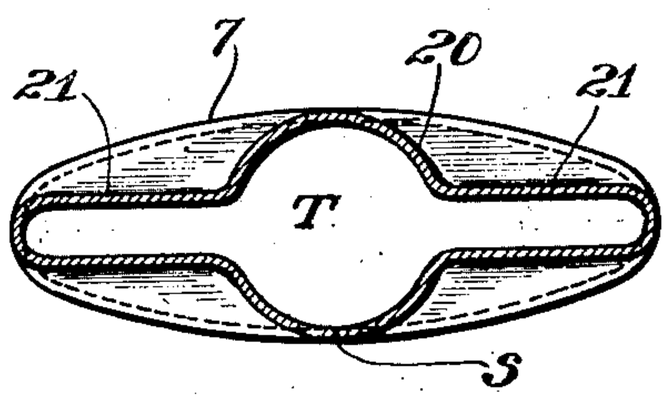


Fig. 3.

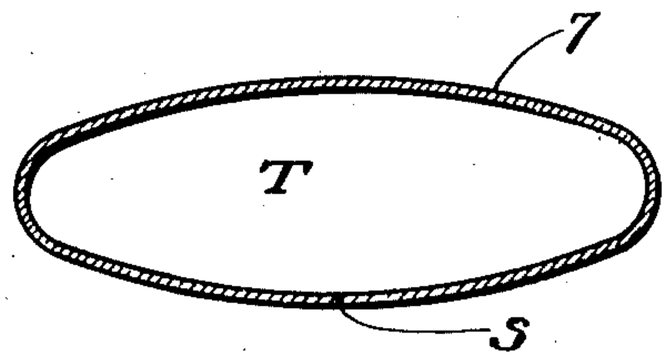


Fig. 4.

WITNESSES

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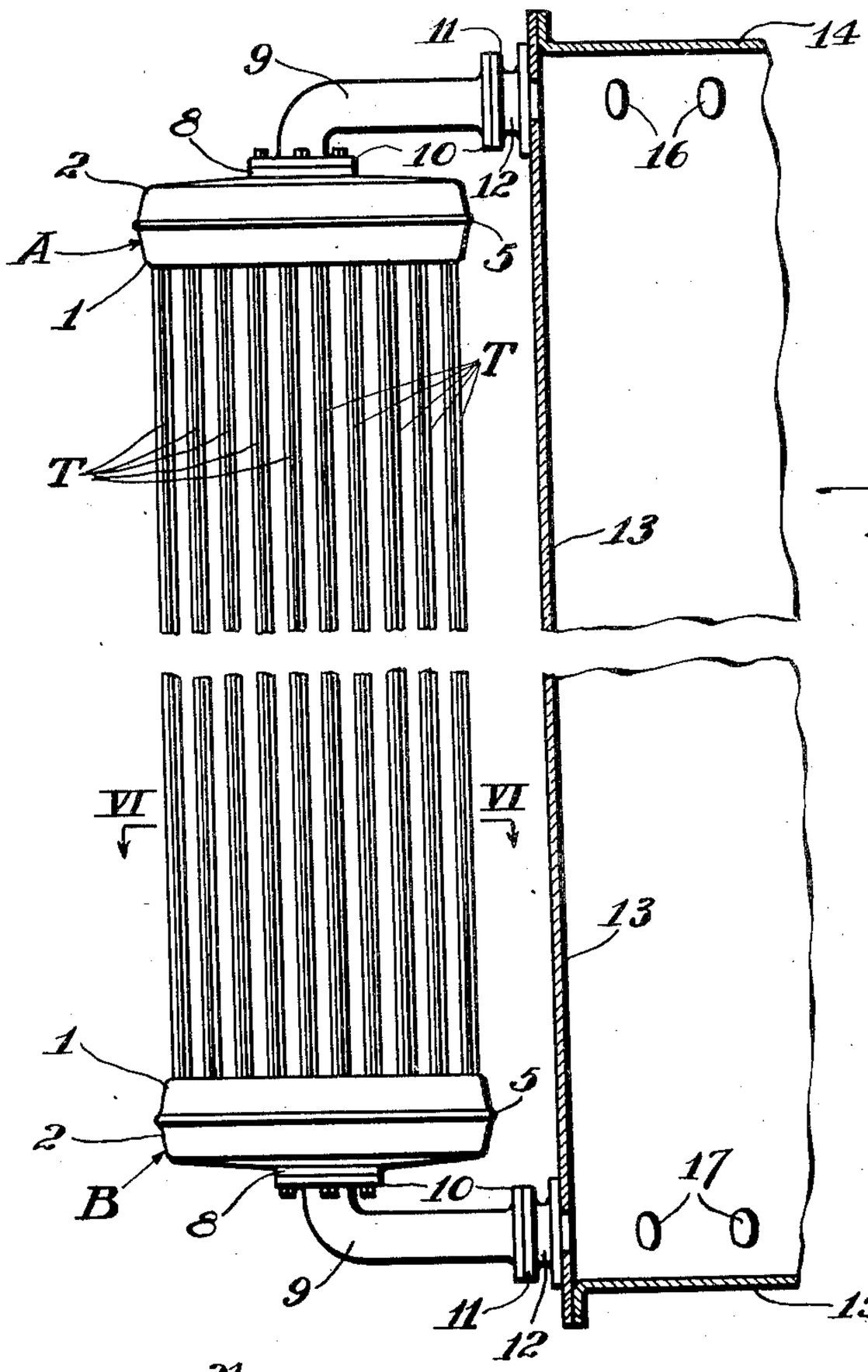

Fig. 5.

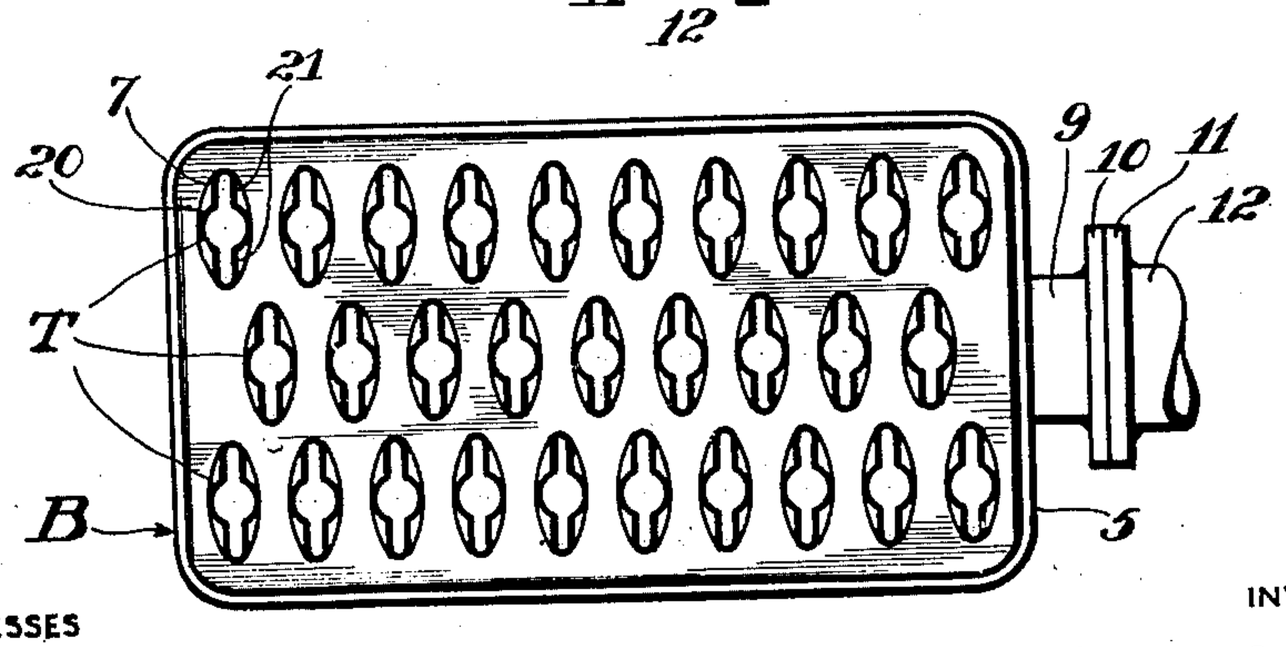

Fig. 6.

WITNESSES

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UNITED STATES PATENT OFFICE

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DEFORMED TUBE RADIATOR

Application filed December 17, 1926. Serial No. 155,410.

This invention relates to radiators.

More particularly the invention relates to multi-tubular radiators, preferably welded into an integral structure, such as are now used as exterior cooling units in connection with transformer tanks. A type of such radiators is shown in my prior Patent No. 1,320,652.

Among the objects of the present invention are to provide an improved multi-tubular thin-walled integral radiator unit having an increased radiating surface in proportion to the cubic contents thereof, giving an increased air circulation therethrough without decrease in the number or effective radiating size of the tubes. An object is to provide for such a radiator tubes having a reduced cubic content, with unreduced radiating surface, and adapted to give increased air space about the exposed radiating surface. Other objects are to provide special tubes making possible the objects above stated which may be used in assembling and making up radiators as described in the said prior patent without modification of the headers or change in the process of assembly and joining of the several elements. Another object is to increase the structural rigidity of such radiators and to decrease the weight of a filled transformer tank and attached radiators. Another object is to provide tubes of special intermediate shape of unreduced radiating areas and which may be drawn through the openings in the headers for repair or replacement; which will permit rapid circulation of liquid through a portion of the tubes but with portions of the walls forming narrow quick-cooling liquid-retarding recesses. Another object is to provide a structure permitting a lesser volume of oil in a transformer tank and external radiation without decrease in radiating efficiency.

Other objects and advantages will be apparent to those familiar with the art.

Referring to the drawings, Fig. 1 is a broken partial central vertical section through one of the radiator headers, and portions of some of the tubes attached thereto, showing various stages in the manufacture of the header and of joining the tubes thereto; Fig. 2 is a side elevation of a detached one of the specially formed tubes for use with such radiators; Fig. 3 is a horizontal section on the line III—III, of Fig. 2; Fig. 4 is a horizontal section on the line IV—IV of Fig. 2; Fig. 5 is a partial vertical section through a transformer cooling tank, showing one of the special radiators herein referred to attached thereto; and Fig. 6 is a horizontal section through the radiator unit on the line VI—VI of Fig. 5.

In recent years there has come into wide commercial use a form of detachable radiator adapted to be connected at its ends to the top and bottom of a cooling tank in which an electrical transformer is submerged in oil. Transformers become heated in use, the insulating oil in which they are submerged absorbs heat from the cores and thereby is caused by thermal action to circulate up and down in the containing tank. By leading this oil out of the top of the tank down through an external radiator, and in at the bottom of the tank, a cooling circulation of the oil is produced, and the heat of the transformer core is thus dissipated by absorption by the oil, circulation of the oil and radiation of the heat thereof through the walls of the external radiating units, which are freely exposed to the air.

The welded-up, sheet metal type is now favored because of the high efficiency of the thin walls, lightness, lack of joints, and general economy of handling, assembly, and transportation. Such radiators are used in connection with transformer cooling tanks by a number of the foremost electrical manufacturers at the present day.

As the size of transformers has increased the tanks have grown higher, and the radiators longer and with more tubes used. Radiators adapted to extend from top to bottom of transformer tanks are now made of a length of as much as fourteen feet, with two sheet metal headers and as many as forty-seven connecting tubes between headers. The weight of oil in the radiating units is a very material factor, not only because of the cost of the oil, but also because of the weight that must be carried by the support of the

unit. It is the practice, and is desirable, to support such units only by the pipe connections to the tank. Also it is the preferred practice to place transformers in the tanks, attach the radiators, and fill with oil at the point of manufacture, shipping the complete, oil-filled tank and radiator. Therefore, it is desirable to reduce the oil content of such radiators, from the point of view of weight and cost of oil, and safety from leaks, due to failure in shipping, and cost of freight.

The radiator illustrated and described herein comprises upper and lower headers A and B, each made up of two oppositely disposed pan-shaped members 1 and 2 having bounding flanges 3 and 4, respectively, adapted to lie flat against each other when the sections are oppositely disposed as shown in Fig. 1. These flanges are united as by electrically welding, soldering, brazing, etc., but preferably by welding with a gas torch, to make a bead or closed seam 5, indicated on the right of Fig. 1.

In forming the header section 1, suitable openings are punched, to receive the tubes T which connect the headers. These openings are bounded by slightly tapered inturned flanges 6, adapted to receive with a tight fit the ends of the tubes T. The tube ends are preferably of an elongated substantially elliptical or oval shape, as shown in Fig. 4. They are preferably formed by bending a strip of sheet metal to the oval flattened form of the final tube with the edges meeting at the middle line of one of the flattened sides. The edges are then butt-welded by the gas torch process to form a seam S.

A tube-receiving opening with its tapered bounding flange 6 ready to receive the oval end 7 of a tube T is shown at the left of Fig. 1. A tube end after being forced into a flanged opening in the header is shown at the middle portion of the top of that figure and a tube end after welding of the end thereof to its bounding flange inside the header section is shown at the upper righthand corner of the same figure. It will be understood that the tubes T are inserted in the perforated pan-shaped section of the header and welded thereto before the two header sections are united to form the seam 5, as previously described.

Suitable connecting members 8 are welded onto the edges of inlet and outlet openings in the upper and lower sections of the upper and lower headers respectively, and to these may be attached tank connections, as for example pipes 9, having flanged terminals 10 adapted to be attached by bolts to similar cooperating flanges 11 upon pipes 12 that are suitably attached to the walls of the transformer tank 13.

The tank 13 is illustrated as having a cover 14 and a bottom 15. Series of aligned openings 16 and 17 are provided around the periphery of the tank near the top and bottom thereof, respectively, for attaching other similar radiators, radially disposed around the tank, as is well understood in this art.

A special feature of this invention is the provision and use of non-circular tubes having their ends of regular flattened oval shape, such as are illustrated in my prior patent above mentioned and which are now extensively used in the art, with their intermediate body portion deformed into a section substantially such as that illustrated in Fig. 3. This comprises a central, substantially circular portion 20, with two laterally extending open wings 21. In deforming the tubes to produce this intermediate portion, the central substantially circular portion 20 is made of a diameter substantially the same as the short axis of the unchanged end portion of the elliptical tube, and the axial median dimension through the two wings is maintained not greater than that of the longer axis of the unchanged end portions of the elliptical tubes. By this arrangement the deformed intermediate portion of the tube is not greater in any through dimension than the original elliptical tube before being deformed on a similar line in the same plane. Or, stated another way, the deformed portion of the tube can pass through any opening that will permit passage of the undeformed elliptical end portions thereof. This is illustrated by the showing of Fig. 3.

By this arrangement, the ends of the tube are unmodified, and therefore the tubes may be attached to the headers exactly as has heretofore been done, without any new assembling operation, or any new welding processes. Also the tubes may be deformed around a mandrel that can then be withdrawn through the elliptical end of the tube. That could not be done if the end were circular.

The particular shape of the intermediate portion of the deformed tube is valuable, since it provides a central circular portion, which shape permits flow of liquid therethrough with a minimum amount of resistance due to contact with the wall of the tube. On the other hand the extensions or wings 21 expose the liquid therein to an increased amount of surface radiation in proportion to the volume of liquid contained therein, the liquid being in a thin column, exposed to cooling air on two sides. If the entire tube were flattened to the narrow form as in the wings, there would be increased radiating exposure but there would be greater resistance to flow of liquid through such a flattened tube, and consequently there would not be a sufficiently rapid circulation for maximum cooling effect. But the liquid may flow comparatively rapidly through the central circular well, or passage. The cur-

rent in the central portion will constantly interchange with the more rapidly cooled liquid in the wing portions. The result is a fairly rapid flow of liquid, with a greatly increased cooling effect in proportion to the volume of liquid in the deformed portion of the tube.

By deforming the intermediate portion in the manner and shape above stated the advantage is maintained of being able to draw the tube out through an opening in the header which will permit passage of the oval undeformed terminal portion thereof. Thus, for example, if a single tube is defective, by opening up the header, the tube may be pulled through the opening therein, exactly as it could have been pulled through without being distorted, since all of the intermediate portions of the tube will pass through any opening that will permit passage of the undeformed end thereof.

The oval shape of the tube before deforming and at the ends after deforming the intermediate portion is desirable for several reasons. In the first place, these tubes are usually made by forming up strips of sheet metal, and welding them by the acetylene process, along the abutting edges of the strips. The welded seam S is made on the middle line of one of the elongated sides. The deforming operation to produce the section shown in Fig. 3 therefore imposes very slight bending strain upon the seam of the original tubes, since the metal at the point where the seam occurs is bent very little.

The elliptical shape of the original tube and of the ends of the deformed tube, is of further importance, since it permits a maximum number of tubes to be used in a radiator of this kind. If circular tubes were used the tubes would have to be spaced apart a greater distance than is necessary with the elongated elliptical shape that is shown.

The regular curve of the oval shape also permits forming of the flanges 6 by a simple punching operation that would not do if the perforations had to conform to the intermediate shape of Fig. 3.

Besides giving an equal amount of surface radiation in the deformed portion, with a reduced volume of cooling liquid therein, the shape shown and described, makes the tubes stiffer, giving more resistance to vibration due to wind strains, and other like causes.

Another and important functional result of this shape is that a greater air space is provided around and between the tubes, thus giving increased efficiency in radiating exposure around the tubes. The space that is removed from the original oil content of the tube by deforming is added to the space around the tubes for exposure to cooling air. Thus a desirable end is secured on both sides of the tube wall.

I claim:

A radiator adapted to be directly attached to and supported by a transformer cooling tank comprising sheet-metal headers having elliptical openings punched therein, inturned flanges bounding said openings, tubes comprising welded seams connecting the headers and attached thereto, the ends of the tubes extending into the openings and the edges of the tube ends being welded to the said bounding flanges, the tubes being formed of sheet-metal and having smooth elliptical shaped ends adapted to fit into said openings the intermediate body of the tubes being deformed to provide a middle circular portion with open flattened wings extending therefrom on opposite sides thereof, the seams of the tubes lying in said circular portion.

In testimony whereof, I sign my name.

CHARLES SONNEBORN.