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R. V. BINGAY

TANK STRUCTURE

Filed June 2, 1920

2 Sheets-Sheet 1

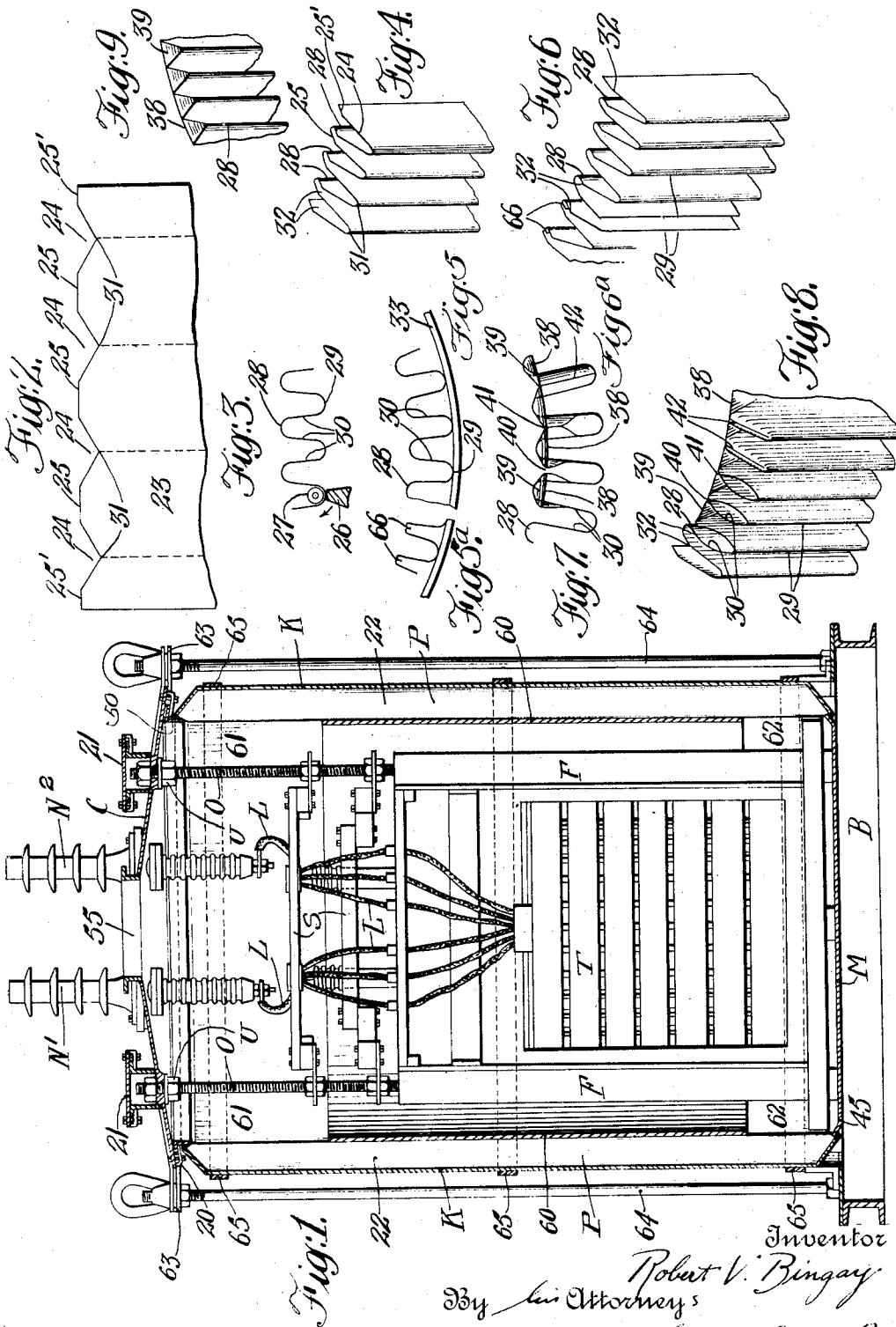


Fig. 1. Inventor
Robert V. Bingay
By *his* Attorneys
Edwards, Sager & Power

Nov. 6, 1923.

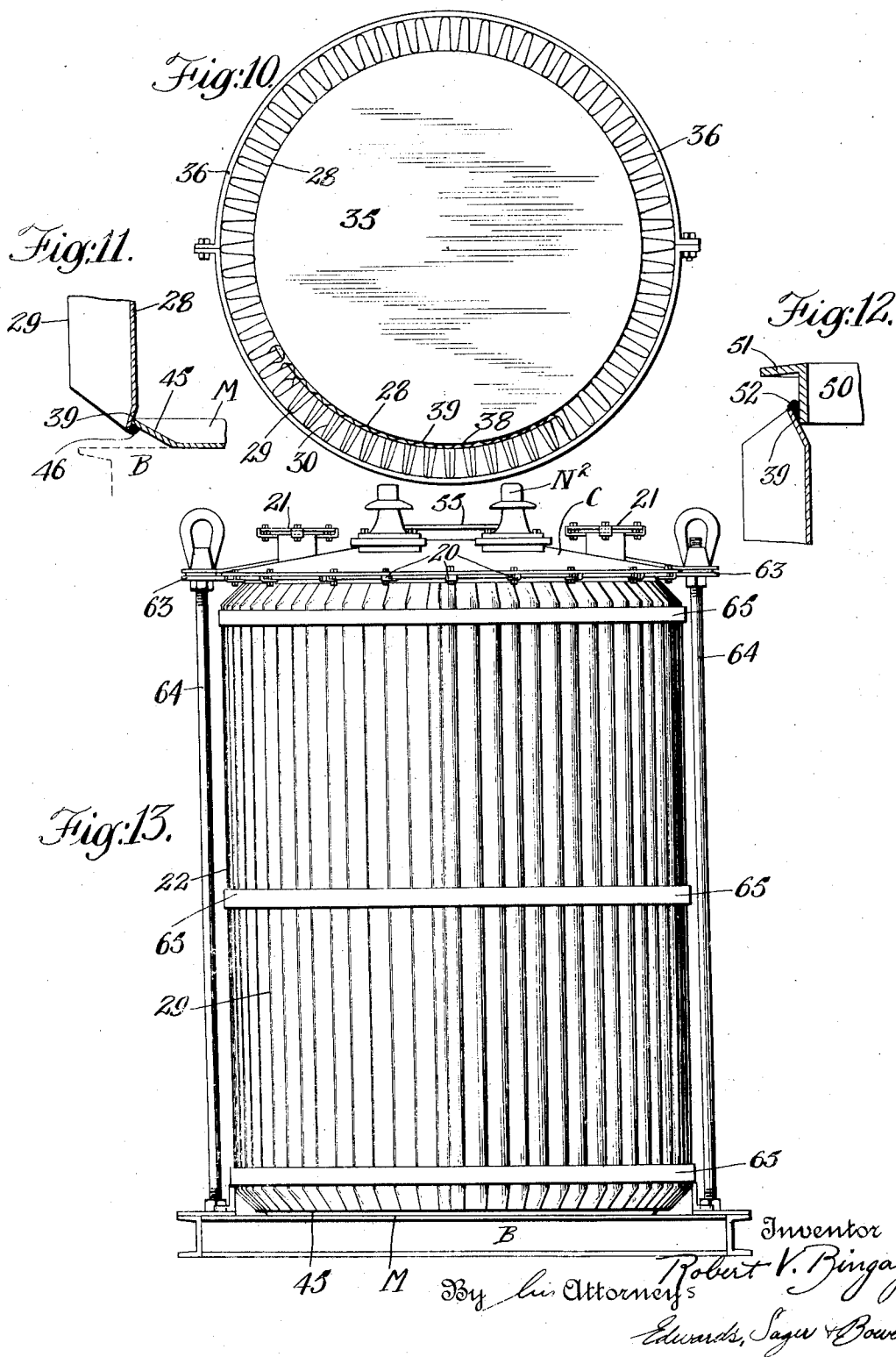
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UNITED STATES PATENT OFFICE.

ROBERT V. BINGAY, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO PITTSBURGH TRANSFORMER COMPANY, A CORPORATION OF PENNSYLVANIA.

TANK STRUCTURE.

Application filed June 2, 1920. Serial No. 386,115.

To all whom it may concern:

Be it known that I, ROBERT V. BINGAY, a citizen of the United States, residing at Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Tank Structures, of which the following is a specification.

This invention relates to electrical transformers and particularly to transformers cooled by the circulation of oil in a tank.

The chief object of the invention is to provide a transformer and tank construction that is inexpensive and strong and adapted to provide for the efficient circulation of the cooling oil.

The transformer tank is preferably formed of sheet steel and further objects of the invention particularly in the method of building up the tank from standard steel parts will appear from the following description taken in connection with the accompanying drawings in which:

Fig. 1 is a vertical sectional elevation of a transformer illustrating a specific embodiment of the invention.

Fig. 2 is a partial plan view of a side section of the transformer tank in the process of formation.

Figs. 3, 5 and 7 are edge views of said side section illustrating successive steps in the formation thereof.

Fig. 5^a is an edge view of a modification.

Figs. 4, 6 and 8 are perspective views corresponding to Figs. 3, 5 and 7 respectively.

Fig. 6^a is a perspective view of a modification.

Fig. 9 is a perspective view of a portion of the tank from inside.

Fig. 10 is an end view of the tank sides.

Figs. 11 and 12 are vertical sectional views of details, and

Fig. 13 is a vertical elevation of the tank in place on its base.

In the specific embodiment of the invention shown in Fig. 1, a transformer T, for instance of the double magnetic circuit type, is supported in frame work F resting on the bottom M of tank K. The tank K stands on the base B and has a cover C fastened to its top by clamps 20. Bolts O extending upward from the frame F pass through the cover C and have their ends enclosed by air

tight caps 21. The cover C also carries the primary and secondary terminal insulators N' and N² and the frame F carries a superstructure S for supporting the leads L to the transformer coils and the terminals.

The tank K is preferably of sheet metal and preferably circular, oval or rounded in section and the sides 22 are corrugated to a depth dependent upon the size of the tank and the relative cooling surface required. Hitherto the depth of these side corrugations has been limited by considerations of strength and the difficulty and expense of producing deep corrugations. The shallower corrugations give a correspondingly restricted cooling surface and often it has been necessary to resort to extra cooling pipes or circulating means where the available air cooling of the tank itself will be sufficient if properly provided for. In the tank of this invention corrugations of the tank body may be of any desired depth and strength required by practice and at the same time these corrugations are formed from sheet metal plates in a simple and inexpensive manner and the resultant structure is strong and self-sustaining and when assembled with the top and bottom portions provides a rigid, durable container.

In building up the tank sides or body 22 a rectangular sheet 23 (Fig. 2) is chosen or cut from the standard sheet steel sizes in stock and the top and bottom edges of the sheet are notched as at 24 leaving straight intervals 25 between the notches, and in the specific example shown leaving half intervals 25' at each end. The notched sheet 23 is then bent into a series of parallel corrugations (Figs. 3 and 4) and preferably the bends are made by a pivoted bender 26 swinging around a former 27 and pressing or wrapping the sheet around the former. This method of bending the corrugations in succession gives a predetermined identical diameter to each bend and avoids any over-stressing of the metal and any irregular or warped effects. The bends 28, 29 at the ends of the corrugations are separated by intermediate substantially flat portions 30 and the inner bends 28 are made between the notches 24 while the outer bends 29 are centered at the peaks 31 of the notches, the ends of corrugated-sections having the form shown in Figs. 3 and 4 with the edges of

bends 28 at right angles to the sheet and the edges of bends 29 inclined. The corners 32 of the notches form a line near the inner bends 28.

5 The next step in the formation of the tank body is illustrated in Figs. 5 and 6 and comprises bending the corrugated section as a whole into a circular arc corresponding in diameter to the diameter of the
10 tank being built. This is accomplished by pressing the inner bends 28 toward each other to slightly narrow the spaces between them and correspondingly spreading apart the outer bends to increase their spacing, a template being used to gage the spacing
15 of the bends. When a number of sections have been formed and curved as shown in Figs. 5 and 6 these sections are assembled side by side in semicircular cradles 33 corresponding to the outer diameter of the tank
20 and the assembled sections are welded together along their meeting edges which are on the inside of the tank, and in this way a circular section is built up in the form for instance of a semicircle and corresponding
25 to half of the tank body. The other half of the tank body is similarly built up and the two halves are assembled together on circular heads or templates 35 (Fig. 10) corresponding to the inner diameter of the
30 tank and are bound thereon by outer hoops 36. The two sections are then welded together along their meeting edges at the inside of the tank.

35 The tank body so formed has its corrugations open at the top and bottom and the next step in the process is the closing of these corrugations in such manner as to form a rigid arched structure in which the
40 corrugations mutually support each other through solid connecting rings at each end of the tank. The closing of the ends of the corrugations is illustrated in Figs. 7, 8 and 9 and comprises a flattening or turning over
45 of the ends of the inner corrugations 28 as indicated at 39. The end edges of these corrugations are thus flattened out into substantially straight lines as indicated at 38 and the ends of the corrugations are spread
50 so as to be brought toward and finally into contact with each other as indicated at 40 and 41. The edges of the intermediate portion 30 and the outer bends 29 are also
55 hammered over and brought into contact along line 42 and welded securely together along this line. The hammering outward of the ends of the corrugations 28 forms the inclined flattened surfaces 39 and brings the extreme ends of these surfaces substantially
60 into the line of the corners 32 of the notches 24, forming a continuous annular ridge around the end of the tank from which the corrugations incline in opposite directions.

65 This gives a strong arched construction

terminating in a solid continuous apex or peak; the end of each corrugation is arched with a central heavily welded seam, and all these arches of the corrugations converge
70 to the top ring so that these corrugations are not only strong in themselves but reinforce and mutually sustain each other through their common connection. All vertical sections through this structure show
75 a characteristic arched form and all horizontal sections also show continuous corrugations with arched connecting bends. With a tank constructed according to the method of this invention it is possible to use a very light gage of sheet steel and all
80 sizes of tanks may be made from stock only about one sixteenth of an inch thick. It is only necessary to carry a very few sizes of steel sheets in stock and from these sizes the desired sections may be readily cut, the
85 number of sections in the tank being easily varied so that a given size of sheet will serve for various sizes of tanks. Each sheet is easily notched to desired contour according to the job in hand and may be notched in part
90 and left plain in part to provide any desired shape for the tank and the sheets before corrugating may be punched out with holes of a shape which will be circular in the
95 finally bent form. The forming of the corrugation bends around a mandrel bends the metal and does not draw or warp or weaken it or leave it with internal stresses. The final closing of the corrugations and
100 welding is done with the tank sections bound together and braced against warping by the inner heads 35 and the outer bands 36.

The two ends of the tank body are substantially identical and comprise a corrugated cylinder with the corrugations inclined
105 and arched at each end and rigidly welded to a continuous annular end portion at each end. This tank body is very strong, irrespective of its connection with the bottom and cover pieces. At each end it provides
110 an annular beveled surface formed by the ring of inclined flattened surfaces 39 and this beveled surface serves for the attachment of the bottom and top pieces in a simple and very rigid manner. When the
115 bottom and top pieces are in place, as hereinafter described, this strong tubular portion reinforces the end portions in such manner that each part is trussed against the other to receive the strains put upon the tank.

The bottom M of the tank is formed by a circular plate, preferably of rolled steel, with its edge flanged upwardly at an angle
125 (Figs. 1 and 11) and this edge flange 45 of the bottom M is nearly at right angles to the beveled surfaces 39 and is just fitted to an intermediate portion of these surfaces. With the bottom piece M assembled and
130 clamped in place a heavy weld 46 is made

in the corner between the surfaces 39 and the flange 45 so that the bottom surface of the tank is below the surface of this weld which will therefore be held spaced from the base B of the transformer in finally assembled position. This flanging of the bottom plate M gives this plate an arched construction and protects it against warping due to the heat of the welding operation and due to any strains on it in service, and this arching at the bottom also holds the welded seam away from contact with the base or other surfaces so that this seam does not collect moisture and become rusty or weaken or wear in use. This construction permits the bottom plate and the top ring, or either, to be made either thicker or thinner than the metal in the tank body, or of the same thickness as may be most advantageous.

The top of the tank body has welded to it the steel or iron angle ring 50, formed by rolling an angle into circular form with its flange 51 inclined at substantially the angle of the tank cover C and the ends of the circle welded together. This ring 50 is sized to fit into the top of the tank and engage an intermediate portion of the beveled surfaces 39 at the top and is fastened in place by heavy welding 52 all around in the annular corner between the surfaces 39 and ring 50. This ring forms additional reinforcement of the tank body and provides a strong and simple connection for the tank cover C.

The cover C which may be of about the same thickness of sheet steel as the bottom M is crowned as shown and fastened to the ring 50 by clamps 20. This cover is provided with the central flanged opening 55 and with terminal insulators N' and N² for the leads. The bolts O of the frame F pass through this cover and are adapted to have eyes screwed on to their upper ends for lifting the frame F and transformer T out of the tank, the cover being lifted with the transformer and the clamps 20 having been released. Underneath the cover C the bolts O carry nuts U bearing against the under surface of the cover and adjusted on the bolts to press upward on the cover and downward on the frame F standing on the bottom M of the tank. The weight of the transformer parts therefore is not carried by the tank sides but is transmitted directly to the bottom M resting on base B. Projections 63 are welded to the edges of the tank cover and through these holding bolts 64 pass to the base B. For further strengthening, if desired, especially in the case of large tanks, one or more reinforcing bands 65 may surround the tank and be welded to the outside bends of the corrugations. In this combination the tank sides or body 22 instead of being under compressive stresses, except by the side bolts 64 at the edges of the cover

has an upward pull transmitted to its upper end by cover C, clamps 20 and angle ring 50. The tank body serves therefore simply as a casing for containing and cooling the oil with which it is filled.

In the combination of this invention the method of forming the tank and the tank body in its trussed or arched structure permit the use of sheet steel stock and this body is furthermore not required to sustain the weight of the transformer parts. The corrugations of the tank body may be made of any depth to give the cooling surface required. These corrugations overhang at the sides and are formed with well rounded bends 29 to give a large passage for the circulation of the oil along the most exposed surfaces and in their entire area provide an extended cross section acting like large pipes for the circulation of the oil. This system in effect makes the pipes or conduits P of the corrugations have a great proportion of their surface exposed to the air. An inner baffle cylinder 60 or guide vane, may be provided just within the bends 29, to separate the inner heated currents of oil from the outer cooled currents. The columns of cooled oil in the corrugations are relatively heavy and pass down rapidly through the corrugations drawing in heated currents of oil at the top 61 and at the bottom 62 replacing the oil rising through the transformer coils.

By the method of this invention the relative area of the outer cooling flutes and the inner passages through and around the coils and core may be made in most effective proportion and this circulatory system provides definite areas of heating and cooling, avoids interference between the rising and descending currents, and in effect gives a forced circulation which by the outer rapid passing of the oil down through the corrugations distributes the heated oil over a larger area of the transformer sides and instead of accumulating as heretofore within a relatively small area at the top with slow and sluggish progress down the sides is rapidly circulated downward through the pipes formed by the corrugations. The temperature gradient at the sides therefore is much less abrupt and the cooling taking place over a much larger area is much more efficient.

The tank of this invention also provides unobstructed paths for the cooling air rising around the sides and in between the corrugations. These corrugations overhang even at their lower ends so that the cooling currents of air have access at the very bottom. They also meet with warm surfaces at a relatively short distance from the bottom and their absorption of heat is distributed over a large proportion of their length of path. All of these conditions make for a

thorough and efficient transfer of heat from the oil within the tank to the air outside so that the tank of this invention will efficiently cool a transformer under conditions where it has heretofore been necessary to use extra radiators or cooling coils or pump circulation.

The method and structure of this invention therefore combine an inexpensive process of manufacture with efficiency and durability in service. This invention is adaptable not only to standard lines and types of transformers to be made up in quantity but also may be readily varied to meet the conditions of particular installations. The number of sections 23 in a given transformer body is a matter of the most economical use of the stock in hand after the desired depth of the corrugations and the total area of the body is determined. With transformers of excessively large size or where great strength is required an increase in the gage of metal in the body may make it economical to make only a single corrugation in each section 23. In such case the bend of this corrugation is directed outward and the inner meeting edges of adjacent sections are also flanged over and turned outward and welded together along the inside between these flanges as indicated at 66 (Figs. 5* and 6*).

While this invention has been illustrated in connection with a specific embodiment of transformer and tank it is not confined thereto but is intended to cover such modifications thereof as fall within the scope of the appended claims. It will also be understood that the parts may, if desired, be brazed instead of welded.

I claim:—

1. A tank comprising a body portion of corrugated sheet metal having corrugations with outer bends formed without welding and the opposite edges of the ends of the corrugations being respectively rounded over and welded together to form an arch, the bodies of the corrugations extending between said welds being bent to form a continuous inclined surface meeting said welds in a continuous ridge, the whole forming a self sustaining unitary structure.

2. A transformer tank comprising a body portion of corrugated sheet metal having corrugations with outer bends formed without welding and the ends of the corrugations respectively rounded over and welded together to form a rounded arch, the bodies of the corrugations extending between said welds being bent to form a continuous inclined surface meeting said welds in a continuous ridge, the whole forming a self sustaining unitary structure, and a bottom plate welded to the inclined surface adjacent the ridge.

3. A transformer tank having a body por-

tion of corrugated sheet metal comprising a series of sections notched and corrugated so that the notched ends of the corrugations are inclined and having the inclined edges of the notched portions welded together, the inner ends of the corrugations being flattened to form an inclined surface meeting the welds in the form of a ridge.

4. A transformer tank having a body portion of corrugated sheet metal comprising a series of sections notched and corrugated so that the ends of the corrugations are inclined and having the inclined edges welded together, the inner ends of the corrugations being flattened to form an inclined surface meeting the welds in the form of a ridge, and a bottom plate having its edges welded to the inclined inner portion of the body adjacent the ridge.

5. A transformer tank having a body portion of corrugated sheet metal comprising a series of sections notched and corrugated so that the ends of the corrugations are inclined and having the inclined edges welded together, the inner ends of the corrugations being flattened to form an inner oppositely inclined surface meeting the welds in the form of a ridge, a bottom plate having its edges welded to the inner portion of the body adjacent the ridge, and a cover supporting ring welded to the inner inclined portion of the upper end of the body adjacent the ridge.

6. A transformer tank comprising a body portion of corrugated sheet metal with corrugations having outer bends formed without welding and the ends of the corrugations bent over to form a flattened inclined surface on one side and a series of oppositely inclined meeting edges on the other, the inclined surfaces and edges meeting in a ridge, and welds formed along said meeting edges.

7. A tank comprising a body portion of corrugated sheet metal, the outer bends of the corrugations being formed without welding and the opposite side edges of the ends of the several corrugations being rounded over to meet each other, the said opposite edges being welded together by a weld on the outer side thereof to form an arch shaped end closure for the corrugation.

8. A transformer tank comprising a body portion of sheet metal notched and corrugated so that the edges of the notches constitute the ends of the corrugations and are inclined inwardly and toward the body-ends, respectively, said inclined ends being rounded over and welded together in arched form.

9. A tank comprising a body portion of sheet metal, a rolled steel end portion having an upwardly inclined circumferential flange, the edge of which abuts but does not lap the body portion, and a weld formed

along the line of contact in the space between the body portion and the lower inclined surface of the flange.

10. A tank comprising a body portion
5 of corrugated sheet steel having a flat circumferential surface and a rolled steel bottom portion, having an upwardly inclined circumferential flange, the edge of which
10 abuts but does not lap the flat portion of the body portion along a circumferential line above the lower surface of said bottom, and a weld formed along the said line of contact.

11. A transformer tank comprising a body
15 portion of corrugated sheet metal with the upper ends of the inner corrugations flattened to form a surface inclined upwardly and outwardly from the axis of the tank, and a top ring formed by an angle rolled
20 into circular form and welded at its meeting ends, the vertical side of the angle being welded to said inclined surface of the body portion and the horizontal side of the angle forming a cover supporting flange.

25 12. A transformer tank comprising a body of corrugated sheet steel having the ends of the inner corrugations flattened to form an

inclined surface, a bottom plate with its edge flanged upwardly and engaging against said inclined surface, and a weld formed in
30 the groove between the lower surface of said plate and the surrounding inclined surface.

13. A transformer tank having a body
35 portion of corrugated sheet metal comprising a series of sections notched and corrugated so that the ends of the corrugations are inclined and having the inclined edges welded together, the inner ends of the corrugations being flattened to form an inclined
40 surface meeting the welds in the form of a ridge, and an upwardly flanged bottom plate having the edges of the flange welded to the inner portion of the body adjacent the ridge.

14. A transformer tank comprising a body
45 portion of sheet metal having corrugations, the ends of which are shaped to form inner circumferential inclined surfaces, a bottom comprising a metal sheet with upturned
50 edges meeting said lower inclined surfaces and welded thereto, and a top portion welded to the upper inclined surfaces.

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