This invention relates to a vapor condenser and method of making the same.

It has heretofore been proposed to make a vapor condenser by providing an inner tubular conduit having exteriorly thereof a spirally arranged fin and installing the same inside of a casing contacting the outer periphery of said spirally arranged fin, so that said fin, together with the inner conduit and the outer casing, provides a spirally arranged passage through which a cooling medium may be circulated for condensing the vapor flowing into said inner conduit. A device of this character has the disadvantage that the spirally arranged fin may be made of any desired radial depth so that the cooling medium passage may be made as radially deep as desired to pass a predetermined quantity of cooling medium therethrough. But a device of this construction has the disadvantage that the actual area of contact of the condensable vapor with a wall which is directly engaged with the cooling medium on the outside is limited to the area of the inner tubular conduit wall however much the depth of the cooling medium passage may be increased, so that dependence has to be placed upon conduction through the spirally arranged fin for increasing the cooling effect due to the larger quantity of cooling medium flowing through the spirally arranged passage as its radial depth is increased.

On the other hand, it has heretofore been proposed to provide a condenser by forming a one-piece tubular corrugated metal wall having corrugations arranged spirally thereof and mounting the same in a casing with the external spaces between the spirally arranged corrugations and the casing providing a spirally arranged passage through which cooling medium may be circulated, while the interior of the corrugated wall constitutes a chamber in which the vapors may be condensed. Such a construction overcomes some of the disadvantages inherent in the structure employing a spirally arranged fin as above referred to in that the area of contact of the condensable vapor with a wall in direct contact with the cooling medium on the outside is increased by reason of the corrugated configuration of the conduit. But a device of this construction has the disadvantage that it has been found impracticable if not impossible to obtain a cooling medium passage of sufficient radial depth to pass the desired quantity of cooling medium, because experience has demonstrated that under known methods of corrugating tubular walls the physical characteristics of the tube to be corrugated impose very definite limitations on the depth and axial width of the corrugations that can be practically formed therein. Moreover, even to obtain corrugations of fair depth only a narrow range of metals or alloys may be employed because of the incapacity, within practicable manufacturing operations, of many metals and alloys, that would otherwise be desirable for use with particular vapors to be condensed, to withstand the stresses to which the tube is subjected in the course of forming relatively deep corrugations therein, even though said corrugations be formed slowly and progressively by rolling or hydrostatic operations. Hence as a practical matter it has been found to be impossible to use certain metals or alloys in condensers employing corrugated walls although highly desirable from the standpoint of the vapors to be condensed, while with all condensers of this character the difficulty has been encountered of increasing to the desired extent the area of the contact of the vapors with a wall directly in contact with the cooling medium on the outside and also in providing a passage for the cooling medium of such radial depth and axial width as to afford the desired cross sectional area, for the flow of cooling medium while still causing it to remain in contact with said wall for the desired length of time owing to the number of circuits of said wall determined by the number of corrugations per unit of length. Hence, condensers of the type employing interior corrugated tubular conduits have had little or no use because of the aforesaid limitations imposed thereon, notwithstanding the advantages of simplicity of construction and assembly possessed thereby.

It is an object of this invention to provide a vapor condenser employing a corrugated wall and method of making the same which retains the advantages above pointed out with respect to the use of condensers having a corrugated inner wall and which at the same time overcomes the difficulties and disadvantages heretofore attendant upon their use.

Another object of this invention is to provide a condenser and method of making the same which combines the advantages of both types of condensers above discussed while avoiding the difficulties and disadvantages heretofore attendant upon their use.

Another object of this invention is to provide a condenser and method of making the same whereby the inner wall thereof in contact with the condensable vapor may be of corrugated form and made of suitable metal for contact with the particular vapor to be handled even though the
metal to be used does not lend itself to corrugating operations when made in tubular form.

Another object of this invention is to provide a condenser and method of making the same whereby the inner wall thereof may be made in spiral form with the corrugations thereof of any suitable depth and width.

Another object of this invention is to provide a condenser and method of making the same whereby the inner wall thereof may be formed by a spirally corrugated wall whose corrugations and of such depth as to afford adequate space for handling the desired flow of cooling medium and at the same time the number of corrugations per unit of length may be made such as to retain the cooling medium in contact with the wall of the condensing space for the desired length of time.

Another object of this invention is to provide a condenser and method of making the same whereby the condenser may be manufactured in relatively large quantities by standardized operations and at a relatively low cost.

Other objects will appear as the description of the invention proceeds.

The method of the present invention may be carried out in different ways and the resulting structure may take a variety of forms one of which is illustrated in the accompanying drawing, but it is to be expressly understood that the drawing is for purposes of illustration only, and is not to be construed as a definition of the limits of the invention, reference being had to the appended claims for that purpose.

Referring to the drawing which illustrates in cross sectional elevation, somewhat diagrammatically, an embodiment of the present invention, 10 is the exterior casing of the condenser, and may be of any suitable size, shape, material and construction. As shown, it has formed thereon or is closely attached thereto a pair of brackets or other appropriate means 11 for mounting the same in any suitable way. Communicating with openings formed in the peripheral wall of said casing, at or adjacent opposite ends thereof, are nipples 12 and 13 secured to the casing in any suitable way and immediately formed for the connection therewith of inlet and outlet conduits for the cooling medium.

Mounted within the casing 10 is a deeply and spirally corrugated metal tube 14 having its outside diameter preferably such that it constitutes a close fit with the interior of the casing 10, so that the outwardly directed corrugations thereof, by engagement with the casing 10 as at 15, provide a continuous spirally directed passage 16 extending from end to end of the casing and through which any suitable cooling medium may be directed. The corrugations of the present invention said spirally corrugated tubular wall 14 are formed so that the spiral passage 16 formed by the corrugations thereof is relatively deep in a radial direction and relatively narrow in an axial direction, so that in cross section the spirally directed passage is sufficiently large for the passage therethrough of the desired quantity of cooling medium to abstract the proper quantities of heat required of the condenser while providing at the same time a sufficient number of circuits within the axial length of the condenser so that the cooling medium is retained in contact with the inner wall thereof for the desired time and carrying away of the desired depth of the corrugations of the desired depth and cross sectional configuration desired for the cooling medium passage of a condenser cannot be readily or efficiently obtained, if at all, because of the relatively great stresses imposed on a tubular wall when an effort is made to form such corrugations therein either by rolling or hydrostatic operations now known to the art, I have found that corrugations of the desired depth and cross section can be readily obtained to secure the desired cooling medium passages by providing a metallic strip of a width approximately equal to twice the desired depth of the corrugation plus three times the semi-circumference of the bends needed to give the walls thereof the desired spacing, and then progressively passing the same between rolls which gradually bend the strip along its medial line while reversely bending the lateral extremities of the strip until the strip is formed into a corrugated strip of opposed lateral walls joined along the medial line by a transverse bend of the desired radius of curvature and having reversely directed curved lateral extremities which may be of the same or a different curvature. The procedure for bending this thin strip may be of any suitable character, such for example as disclosed in the patent to Harrali, No. 1,064,299, granted June 26, 1914, for Manufacture of conduits. The bent strip may be readily called upon itself in the course of its manufacture so that the curved lateral extremities thereof are overlapped as illustrated on the drawing, and a hermetic seal may then be formed between these overlapping surfaces in any suitable manner by melting an interposed strip of wire solder or by welding or otherwise sealing the joint between the contacting surfaces. In the drawing said overlap is shown at the inner bends, but it will be appreciated that the corrugated strip may be formed so that the overlap occurs at the outer bends, and this is preferred for some constructions.

As the metal in the course of its progressive deformation into the corrugated form as heretofore described is not subjected to the stresses of forming deep corrugations in a tubular strip may be selected of suitable width so that corrugations of the desired depth and cross section may be obtained, thereby increasing the total surface of the corrugated wall to that extent desired to afford the desired area of heat exchange therethrough, while at the same time the corrugations of such cross sectional configuration that the desired radial depth and axial width are obtained to secure the desired rate of circulation of cooling medium therethrough and length of contact therewith. Moreover, as a result of the manner in which the strip is formed, the strip may be selected of a metal or alloy suitable for the media in contact therewith although such metal does not lend itself to cor-
rugation in tubular form. Also, the strip may be made of the desired thickness although a similar thickness could not be used when corrugating a tube either because the metal would be too thin to withstand the stresses arising from the changes of diameter involved or so thick that by its stiffness it would unduly resist if not prevent the formation of the desired corrugations therein.

The corrugated tube 14 may be sealed in the casing 10 in any suitable way. As shown, one end of the casing 10 has an inwardly directed flange 17 which interlocks with a similarly directed flange 18 of an end closure member 19 of any suitable form, here shown as having sealed in a central aperture thereof, as by soldering, a nipple 20 having an interior passage 21 which communicates with a radially directed pipe 22, said nipple 20 being formed in any suitable way for the connection of a conduit thereto. Closure member 19 may be sealed in the channel-shaped flange 17 in any suitable way, as by soldering. Attached to the closure member 19 in any suitable way is an annular channel-shaped member 23 which is adapted to receive the corrugated wall 14 and said channel is preferably of sufficient depth so as to receive more than one corrugation thereof as shown. By standing the casing 10 on end the channel in said member 23 may be filled with fluid solder of any suitable characteristic, as indicated at 24, and the end of the tubular wall 14 may be held therein until the solder congeals to permanently lock the end of the tubular wall 14 in position. The opposite end closure may be, and is shown as, of identical construction with that just described, including a central nipple 25, radial nipples 26, and having a passage 27 leading to a radially directed tube 28, said end closure member 25 having suitably attached thereto a channel-shaped member 29 in which said solder 30 may be placed while the casing is on end and into which the end of the wall 14 may be inserted and held while the solder congeals to lock this end of the tubular wall 14 in place, after which the end of the casing 10 may be suitably bent or swaged at 31 around the peripheral flange 32 on the end closure member 25 to lock the same in position, said bending being done between the casing and the closed off end of said tube 28. The vapor to be condensed enters the chamber defined by the corrugated wall 14 through one or the other of the nipples 25 and 26 and having been condensed therein the condensate may be withdrawn from or flow through the other of said nipples while cooling medium in proper volume is caused to flow through the spiral passage 16 as heretofore described. The vapor within the condensing chamber 33 is in direct contact throughout its area with the corrugated wall also in direct contact throughout the same area with the cooling medium flowing through said spiral passage 16, and hence the area for heat interchange is relatively large. By reason of the corrugations being formed in the manner heretofore described said corrugations can be made of the desired depth and axial width which are not only suitable for increasing the area of heat interchange between the vapor and cooling medium to the desired extent but also to predetermine the cross section of the passage 16 for the desired flow of cooling medium and length of contact therewith. Thereby the condenser may be made of suitable size to handle efficiently the required volume of vapor, and the wall in heat exchanging relation with the vapor and cooling medium may be made of desired thickness. The surface in contact with the vapor may also be formed of a metal that not only facilitates heat exchange but also one that will not react with the vapor. Hence a highly efficient condenser has been provided, and at the same time the parts thereof readily lend themselves to high speed production without the use of highly skilled labor, and as assembly of the component parts is relatively simple, the condenser may be produced at relatively low cost.

While the embodiment of the invention illustrated on the drawings has been described with considerable particularity, it is to be clearly understood that the invention is not restricted thereto as the invention may receive a variety of mechanical expressions, some of which will now readily suggest themselves to those skilled in the art, while changes may be made in the details of construction, arrangement, proportion, etc., of parts without departing from the spirit of this invention. Thus, for example, other means for attaching the end of the corrugated inner wall to the outer casing, other forms of end closure, brace end of the corrugated wall 14 and said channel may be employed within the purview of this invention. Furthermore, while the preferred procedure of forming the corrugated inner wall has been described with considerable particularity, it is to be expressly understood that within the broader aspects of this invention any suitable procedure may be employed for forming spiral corrugations of desired proportions from a strip of metal and making a chamber therefrom. Reference is therefore to be had to the appended claims for a definition of this invention.

What is claimed is:

1. The method of making a condenser which includes the steps of forming a spirally corrugated tubular wall having corrugations whose depth is materially greater than their width, providing a casing with an end closure having an annular channel, filling said channel with fluid solder while said casing is on end, holding one or more corrugations at the end of said corrugated wall in said solder until the same is congealed, providing a similar closure for the opposite end of said casing, filling the channel thereof with fluid solder, and inverting said casing and holding one or more corrugations at the opposite end of said corrugated wall in said last named solder until the same is congealed.

2. A condenser comprising a casing having opposite end walls provided with inlet and outlet connections and also having inlet and outlet connections for a circulating medium communicating with the interior thereof through the peripheral portion of said casing, a spirally corrugated tubular wall having corrugations whose depth is materially greater than their width disposed axially within said casing with the outer bends of said corrugated wall in contact with said casing whereby said corrugations form with said casing a spiral passage in communication with said connections for the circulating medium and having its radial depth materially greater than its axial depth, and means for sealing the ends of said corrugated wall into said casing including channel shaped members carried by said end walls and containing congealed solder in which one or more corrugations at each end of said corrugated wall are imbedded.

3. A condenser comprising a casing having opposite end walls provided with inlet and outlet connections and also having inlet and outlet connections for a circulating medium.
casing with the interior thereof through the peripheral portion of said casing, means within said casing providing with said casing a spirally directed passage in communication with said connections for the circulating medium, said last named means including a deeply corrugated tubular metal wall formed of relatively thin metal and having corrugations whose radial depth is materially greater than their width, said corrugated wall having its outer bends in contact with the peripheral wall of said casing and including a continuous metal strip of U-shaped cross section having relatively long legs with the extremities thereof reversely curved and coiled upon itself in overlapping relation at said reversely curved portions, whereby said spirally directed passage has a radial depth which is materially greater than its axial width and the circulating medium is in heat interchanging relation with the space interiorly of said corrugated wall substantially throughout the surface of said corrugated wall, and means sealing the ends of the corrugated wall to the end walls of said casing.

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