April 7, 1942. B. LEWIS 2,278,791

METHOD OF FORMING SINUSOIDAL GROOVES

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Fig. 1.

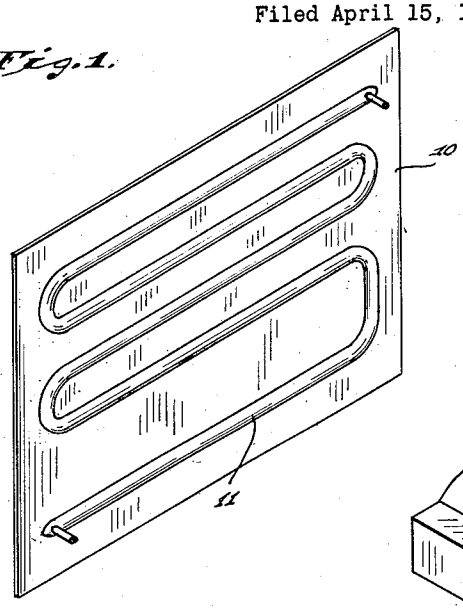


Fig. 2.

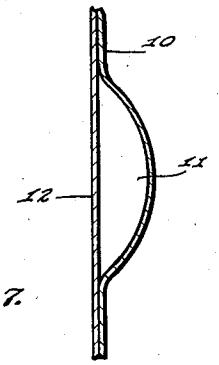


Fig. 7.

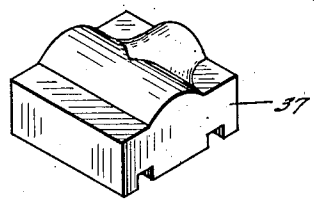


Fig. 3.

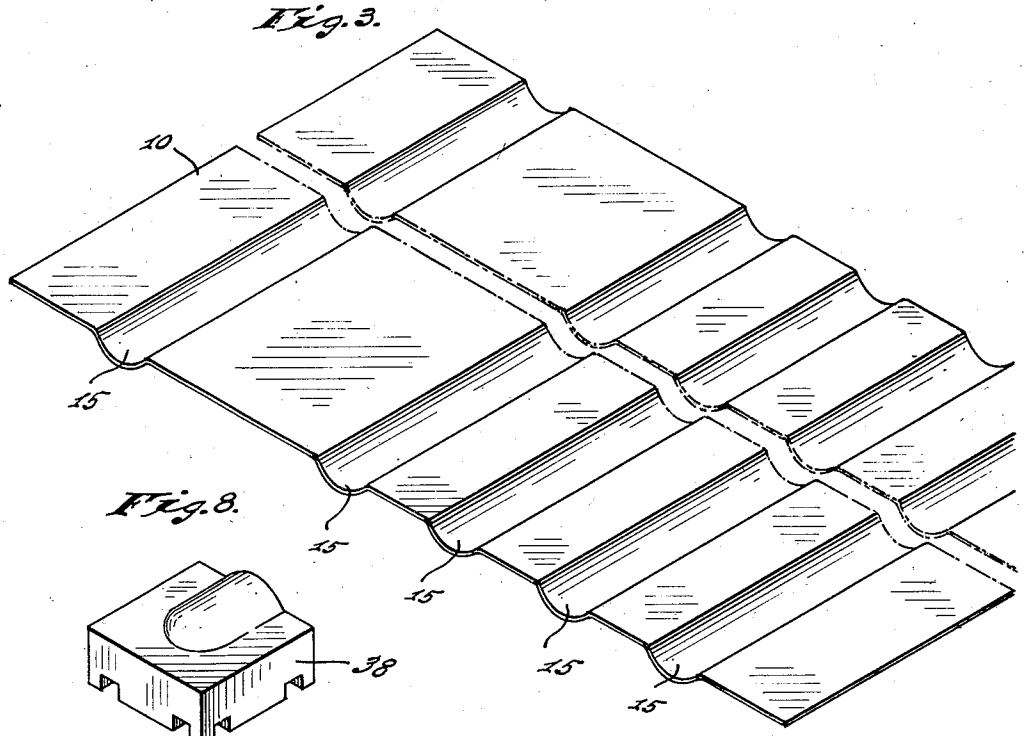


Fig. 8.

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Fig. 5.

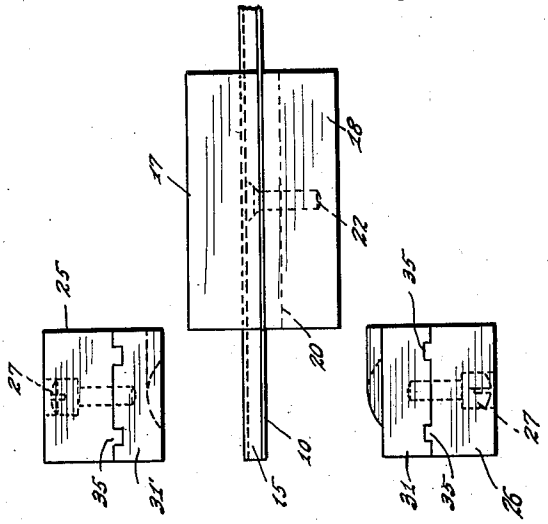


Fig. 4.

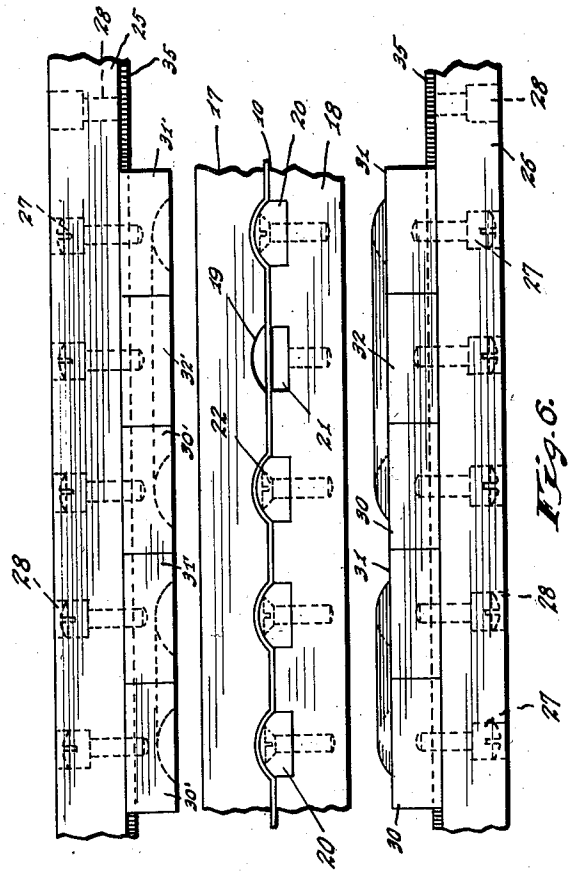
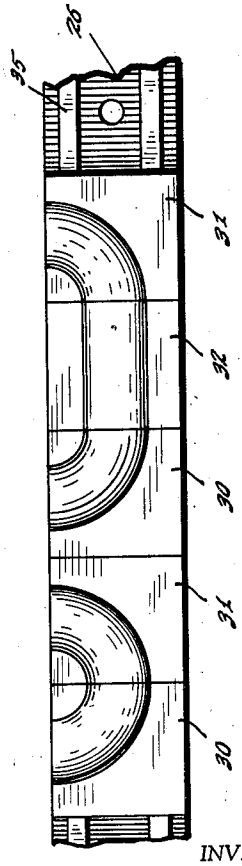


Fig. 6.



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METHOD OF FORMING SINUSOIDAL GROOVES

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3 Claims. (Cl. 153—68)

In evaporators for use in refrigerating apparatus, a common form of construction embodies a wall panel formed of two superposed plates one of which is provided with a sinusoidal groove opening toward the other end forming a refrigerant passage when the two plates are secured together. Panels of similar construction are not infrequently used in coolers, condensers, and in heat-exchangers generally.

In situations where the number of such panels to be produced in any one size does not justify the expense of dies capable of forming the sinusoidal groove in one operation, the formation of that groove has been relatively troublesome and expensive. It is the object of my invention to simplify, expedite, and lessen the cost of forming such a groove in a metal plate in situations where the number of panels of any one size to be produced is relatively small.

In carrying out my invention I first adopt a groove cross-section of a convenient size and shape, and I also adopt a standard minimum spacing for adjacent parallel stretches of the groove. I then take a metal sheet of a size suitable for forming the finished panel and form it with parallel grooves of the desired cross-sectional shape and size extending from one edge of the sheet to the opposite edge, the center-lines of each pair of adjacent grooves being spaced apart a distance equal to an integral multiple of the standard groove-spacing. These grooves may be formed on a press brake or on any other type of suitable equipment available. The sheet thus grooved is then formed at its ends to provide transverse passages interconnecting the parallel grooves in series or in any other desired arrangement. For this purpose, I employ a pair of clamping members which can readily be adapted to grip and support adjacent its edge any sheet provided with grooves of standard cross-sectional shape spaced at distances equal to integral multiples of the standard groove-spacing; and I provide co-operating sets of dies which operate on the edge of a sheet projecting from the clamping members to form the transverse passages. Each set of such dies embodies a plurality of sections each having a width corresponding to the standard groove-spacing and provided with metal-forming portions adapted to form straight transverse grooves, 90° elbow grooves, or grooves of any other desired shape in plan. For any given panel, die-sections are selected and arranged upon a common support to provide the desired interconnection for the ends of the parallel grooves in the metal sheet.

The accompanying drawings illustrate my invention: Fig. 1 is an isometric view of a panel of the type formed in the practice of my invention; Fig. 2 is a fragmental vertical section through the panel of Fig. 1; Fig. 3 is an isometric view of the metal sheet as grooved in the first step of my process; Fig. 4 is a front elevation of the dies and holding members employed in forming the edge of the metal sheet; Fig. 5 is an end elevation of the dies and holding members shown in Fig. 4; Fig. 6 is a plan view of the lower set of dies; Fig. 7 is an isometric view of a single die section which which can be used when grooves in the metal sheet are to be interconnected in multiple; and Fig. 8 is an isometric view of a die section suitable for use in merely closing the end of a groove.

The panel unit illustrated in Fig. 1 consists of a plate 10 formed with a sinusoidal groove 11 having a plurality of parallel stretches and a second plate 12 overlying the plate 10 and co-operating with the groove 11 to define a continuous sinusoidal passage. At the sides of the groove 11, the two plates 10 and 12 are secured together, as by welding, to prevent cross-flow between adjacent stretches of the passage. As above indicated, this type of unit is old; and my invention is confined to the apparatus and process used in forming the sinusoidal groove 11 in the plate 10.

In the first step in the practice of my invention a metal sheet of a size suitable for forming the plate 10 is provided with a series of parallel grooves 15 extending from one edge of the sheet to the opposite edge and spaced at intervals corresponding to the spacing of the parallel stretches of the groove 11 in the finished plate. Desirably, the grooves 15 are all of the same cross-sectional size and shape, and adjacent grooves are spaced apart a distance equal to an integral multiple of a certain standard spacing. In the specific sheet illustrated in Fig. 3, the spacing of the four grooves at the right is equal to the standard groove-spacing, while the spacing between the two grooves at the left, is equal to double that distance; but this illustration is merely by way of example.

To finish the sheet illustrated in Fig. 3, it is necessary to bring the material at the ends of the grooves into the plane of the ungrooved portion of the sheet and to provide between the grooves transverse passages which interconnect them. To accomplish this result, I use apparatus of the type illustrated in Figs. 4, 5, and 6. This apparatus comprises a pair of clamping members 17 and 18 one of which, shown as the upper member

17, is provided with a series of parallel grooves 19 corresponding in cross-section to the outer wall of the grooves 15 in the sheet 10. All the grooves 19 are spaced apart a distance equal to the standard groove-spacing. The lower clamping member 18 is adapted to have applied to it a series of parallel ribs 20 having upwardly extending convex surfaces corresponding in cross-sectional shape to the inner wall of the grooves 15. The arrangement is such that a rib 20 may be mounted on the holding member 18 opposite each of the grooves 19 in the other holding member. A preferred structure is illustrated in the drawing, where the holding member 18 is shown as provided with a series of parallel grooves 21 spaced apart a distance equal to the standard groove-spacing and each adapted to receive a rib 20. As illustrated, screws 22 are provided for holding the ribs 20 in place.

In arranging the clamping members 17 and 18 for use on any specific grooved sheet, the ribs 20 are arranged on the clamping member 18 in a manner corresponding to the arrangement of the grooves 15 in the sheet 10. That is, wherever the grooves 15 in the sheet 10 are spaced apart a distance equal to the standard groove-spacing, there will be a rib 20 in each of the grooves 21; but where the spacing of adjacent grooves 15 in the sheet 10 is greater than the standard groove-spacing, one or more of the ribs 20 will be omitted in order that the ungrooved portion of a plate 10 clamped between the members 17 and 18 will not be deformed. This will be clear from Fig. 4, where the second groove 21 from the right is shown as having no associated rib 20.

The dies used in forming the edges of the grooved sheet are supported upon upper and lower backing members 25 and 26. These dies are made up of individual sections each having a width equal to the standard groove-spacing, and are individually secured to the associated backing member as by screws 27 which pass into the die-sections through holes 28 in the backing member. These die-sections may take various forms, the forms illustrated in Figs. 4 to 6 including mating sections 30 and 30' adapted to form a right-hand elbow, mating sections 31 and 31' adapted to form a left-hand elbow, and mating sections 32 and 32' adapted to form a short straight groove extending transversely of the grooves 15 in the sheet 10. In Figs. 4 and 5, the sheet 10 is shown as arranged with the grooves 15 opening downwardly, and the various male die-sections 30, 31, and 32 are arranged on the lower backing member 25, while the die-sections 30', 31', and 32' are secured to the upper backing member. To hold the die-sections on the associated backing members in proper alinement with each other, they may be provided with parallel grooves for the reception of guide ribs 35 extending longitudinally of the backing members.

The length of the clamping members 17 and 18 and backing members 25 and 26 is at least as great as the width of the widest panel which the apparatus may be called upon to produce; but the ribs 20 will be arranged on the clamping member 18, and the die-sections need be arranged on the backing members only over those portions of the length thereof which will be occupied by the sheet 10 to be formed. Where the ends of two adjacent grooves 15 of standard spacing are to be interconnected, two die-sections 30 and 31 will be disposed in side-by-side relationship on the backing strip 26 and two die-sections 30' and 31' will be secured respectively above them on the clamping member 25 as indicated at the left in Figs. 4 and 6. Where the grooves 15 to be interconnected are spaced apart a distance greater than the standard unit distance, die-sections 30 and 31 on the backing member 26 will be separated by one or more die-sections 32, and die-sections 30' and 31' on the backing member 25 will be separated by a corresponding number of die-sections 32', as indicated at the right in Figs. 4 and 6.

With the ribs 20 arranged on the clamping member 18 in a manner corresponding to the spacing of the grooves in the sheet 10, and with the various die-sections arranged on the backing members 25 and 26 in a manner which will effect the desired interconnection of the grooves 15, the plate 10 is clamped between the two clamping members 17 and 18 as illustrated in Figs. 4 and 5 leaving the edge portion of the plate 10 projecting between the retracted sets of dies. The two sets of dies are then brought together on the projecting end of the plate 10 to flatten the material at the ends of the grooves 15 and to interconnect those grooves in series.

If it is desired to connect grooves together in multiple rather than in series, such result can be accomplished by utilizing the necessary number of T-forming die-sections 37 (Fig. 7) on the lower backing member 26 and a corresponding number of mating female die-sections (not illustrated) on the upper backing member 25. Where it is desired merely to close the end of any groove 15, or to close the end of a cross connection formed by a die 37, I may employ a male die-section 38 (Fig. 8) suitably positioned on the backing member 26 and a mating female die-section (not illustrated) above it on the backing member 25.

It will be noted that sheets 10 of widely different size and having grooves 11 of widely varying pattern may be produced with relatively simple apparatus. The same die-sections can be used in the formation of sheets of different size and groove-pattern, it being necessary only to select the proper die-sections from a limited number of types and to arrange them on the backing members to effect the desired interconnection of the grooves 15. In most cases the pattern of the connecting grooves will be different at the two ends of the sheet, but the rearrangement of die-sections thus made necessary may be easily and quickly effected.

Since each die-section will ordinarily be secured to its associated backing member in a position co-ordinated to the location of grooves 15 in the sheet 10, and since those grooves will be spaced at integral multiples of the minimum groove-spacing, it is necessary to provide for mounting the die-sections only in a limited number of positions along such backing member. The distance between adjacent ones of said positions will be equal to the standard groove-spacing; and, when the die-sections are held in place by the means illustrated, the holes 28 will therefore be spaced at intervals equal to that standard groove-spacing.

I claim as my invention:

1. A process of forming in a metal sheet a sinusoidal groove having spaced parallel stretches, comprising deforming a plane metal sheet to provide therein grooves extending from one edge of the sheet to the opposite edge, said grooves being spaced at intervals corresponding to the spacing of the parallel stretches of the sinusoidal groove to be produced, and subsequently bring-

ing adjacent material at corresponding ends of the grooves into the plane of the ungrooved portions of the sheet and forming near each said edge of the sheet grooves interconnecting said first named grooves.

2. The invention set forth in claim 1 with the addition that said operation of displacing the material at the ends of the grooves and said operation of forming interconnecting grooves are performed simultaneously at each edge of the sheet.

3. The invention set forth in claim 1 with the addition of clamping the grooved and ungrooved portions of the sheet adjacent the edge thereof while the forming operation at such edge is being performed.

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