May 9, 1961 A. B. MODINE 2,983,483

METHOD OF RADIATOR CORE FIN ASSEMBLY AND FIN ELEMENT THEREFOR

Filed Dec. 19, 1955

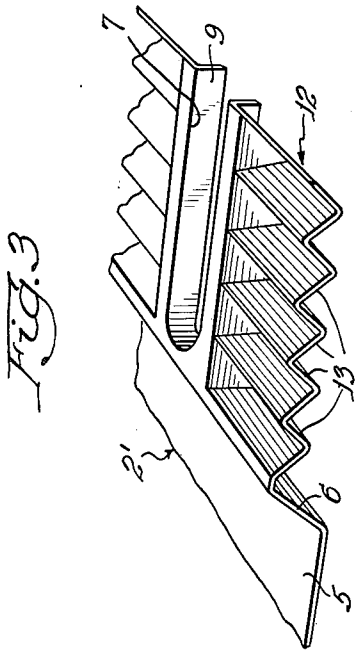

Fig. 3

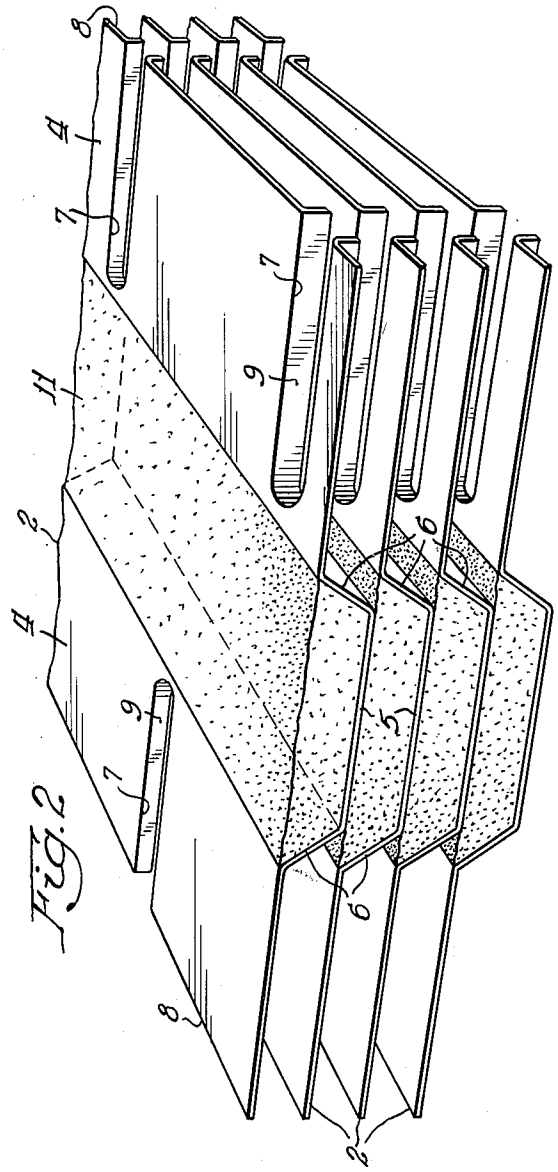

Fig. 2

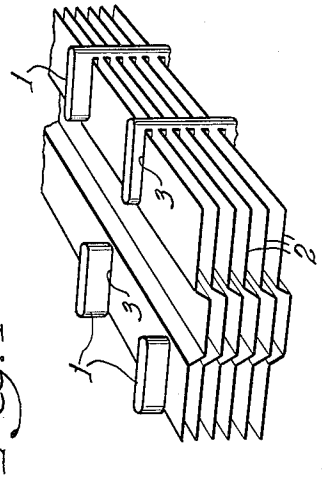

Fig. 1

Inventor:
Arthur B. Modine
By: Slee & Slee
Attys.

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METHOD OF RADIATOR CORE FIN ASSEMBLY AND FIN ELEMENT THEREFOR

Arthur B. Modine, Racine, Wis., assignor to Modine Manufacturing Company, Racine, Wis., a corporation of Wisconsin

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29 Claims. (Cl. 257—130)

The invention relates generally to heat exchange structures, and more particularly to a novel fin structure and method of making the same. This invention also relates to an improved method and fin structure for fabricating a heat exchange structure for an automotive radiator such as disclosed and claimed in the copending application of Charles T. Perkins, Serial No. 223,946, filed May 1, 1951, now abandoned for Radiator Core and Method of Assembly Thereof and assigned to a common assignee, Modine Manufacturing Company, Racine, Wis.

The present invention is of particular application in the manufacture of heat exchange structures utilizing relatively thin sheet material as secondary heat transfer surface, and has among its objects the utilization of a novel method and structure whereby the sheet material may be accurately positioned and supported with respect to similar members, insuring a high degree of accuracy in assembly.

A further object of the invention is the utilization of such a novel method having the above advantages, and which enables the use of very thin sheet metal which otherwise could not satisfactorily be employed, as well as enabling the use of fin members which are so contoured that assembly could not be accomplished in conventional types of jigs or fixtures.

A further object of the invention is the utilization of such a method and the production of a fin structure which may be fabricated from very thin gauge materials and at the same time have adequate rigidity to permit normal handling, etc., without damage to the light gauge material.

A further object of the invention is the utilization of such a novel method which may also provide a fluxing action prior to the bonding of the elements of the heat exchange structure.

A further object of the invention is the production of a fin element utilizing very thin gauge material in combination with a material carried by the fin element, which material is adapted to be removed from the structure following assembly thereof, prior to or during the bonding operation.

Many other objects and advantages of the construction herein shown and described will be obvious to those skilled in the art from the disclosure herein given.

To this end my invention consists in the novel construction, arrangement and combination of parts herein shown and described, and more particularly pointed out in the claims.

In the drawings, wherein like reference characters indicate like or corresponding parts:

Fig. 1 is a perspective view of an assembled heat exchange structure embodying the invention;

Fig. 2 is an enlarged perspective view of a plurality of stacked fin elements constructed in accordance with the invention; and

Fig. 3 is a modified fin structure similar to that illustrated in Fig. 2.

The invention contemplates the utilization of fin elements, as for example, of the general type commonly employed in heat exchangers of the tube and fin type wherein a plurality of usually parallel tubes are assembled with a plurality of sheet metal fin members which extend transversely to the axes of the tubes and are secured thereto in heat transfer relation.

Fig. 1 illustrates a portion of an exchanger of this general type embodying the present invention, wherein a plurality of generally vertical tubes 1 are connected in heat transfer relation to a plurality of sheet metal fin elements 2, the tubes 1 in the embodiment illustrated being positioned in respective recesses or slots 3 formed in the members 2 with the slots 3 each opening on one of the respective longitudinal edges of the particular fin element, whereby the tubes 1 may be inserted into a plurality of stacked fin elements from the edges thereof. This construction is somewhat similar to that illustrated in Summers Patent No. 1,913,175. The invention, however, is equally applicable to the common tubular type exchanger in which the tubes are inserted through aligned apertures or holes in a series of stacked fin elements, whereby each fin element completely encircles each tube associated therewith, as well as other fin structures.

It will be appreciated that in commercial production of heat exchange structures of the type described, selection of the material forming the secondary heat transfer fins often is not predicated upon the requirements of the heat exchange characteristics desired, but upon the physical characteristics of the material as to tensile strength, bending, etc., as a result of which considerably heavier fin materials are often employed than would be necessary to provide suitable heat transfer characteristics. Many times, such a selection is necessitated by the inability to fabricate, handle and assemble fin structures made of very thin material, which while possessing suitable heat exchange characteristics for the particular application, cannot withstand normal handling involved in the manufacture thereof. The invention thus provides a means of stiffening light gauge sheet metal whereby fin elements formed from the same may be handled and assembled with a reasonable amount of care without damage to the fin structure.

Referring to Fig. 2, each fin member or element 2 may be formed from very light sheet material, as for example, foil-like sheet metal—the thickness of which may be in the neighborhood of four-thousandths of an inch or less. The particular embodiment of the invention illustrated is provided with longitudinally extending edge portions 4 lying in a common plane and an offset intermediate portion 5, the latter being connected to respective portions 4 by angularly extending connecting portions 6. The portions 4 are each provided with a plurality of tube-receiving slots 7 opening on the longitudinal edges 8 of the respective members, each opening 7 being defined by a transversely extending flange 9 formed from the material comprising the fin element 2. As illustrated, the openings 7 along one edge 8 of the fin may be longitudinally staggered with respect to the openings on the opposite edge of the fin, so that the assembled structure will present the tubes 1 in longitudinally staggered relation as distinguished from an in-line relation.

Following forming of the fin members, preferably immediately thereafter, a suitable adherable material may be deposited in the channel formed by the intermediate portion 5 and inclined connecting portions 6 to form a strip or block 11 of such material. The composition of the material 11 is preferably one that has adequate tensile strength to withstand normal handling to which the fin member 2 may be subjected without breakage and at the same time be capable of ready removal from the fin member when desired by subjection to predetermined conditions. Among the materials which may be

suitable for use are various thermo-plastics which are relatively rigid at normal temperatures but have relatively low melting temperatures. In some instances where desired for special reasons, other materials may be employed which are not dependent upon heat for their removal, as for example, a suitable water or other liquid soluble material.

It will be appreciated that the strip or block 11 extending the length of the fin member, while not extending from edge to edge of the fin element in the embodiment illustrated in Fig. 2, will prevent undesired bending of the fin strip in a transverse direction and will thereby tend to prevent undesired deformation of the longitudinal portions 4 of the strip, the flanges 9 defining the recesses 7 also serving to provide additional rigidity. The material 11 may also be utilized to perform a spacing function as clearly illustrated in Fig. 2, wherein successive portions 5 are seated upon and supported by the block of material 11 of the preceding fin member. Thus following assembly of the fin members in the manner illustrated in Fig. 2; which, for example, could be accomplished by stacking the members in a suitable box or tray, the tubes 1 may be readily inserted in the slots 7 in the manner illustrated in Fig. 1. Following assembly of the fin members with the tubes, assuming the material 11 is of a thermo-plastic type, the assembled structure may be placed in a suitable heating chamber or oven; and, while supported from its periphery, heat may be applied to liquify the material comprising the blocks 11 and effect the removal thereof from the structure. Assuming the bonding material was previously applied to the exterior surfaces of the tubes 1 or to the flanges 9 of the fin members, the assembled structure could then be brought up to the bonding temperature, resulting in the bonding of the tubes to the respective fin members. In many cases it may be desirable to incorporate a flux material such as a small amount of a non-corrosive paste flux with the material such as beeswax of the block 11 whereby the melting of the latter will simultaneously accomplish a fluxing operation on the assembled structure, thereby eliminating a separate fluxing operation.

Where the incorporation of a fluxing material with the thermo-plastic material is not desired, a stop-off material containing the flux may be applied where desired along the fin to prevent spreading of the spacing material to bonding areas and at the same time provide the flux for the bonding operation.

While I have illustrated the spacing material as being positioned adjacent the central or intermediate portion of the fin structure in a single strip or block, obviously one or more strips may be utilized along different portions of the fin member, as for example, along the edge, etc., the particular configuration depending upon the design of the fin element.

Similarly, where I have illustrated the contour of the portions 4 of the fin intermediate the tubes 1 as being planar, obviously such portions could be contoured if desired. An example of such a construction is illustrated in Fig. 3, wherein the intermediate portions 12 of the fin member 2' are provided with longitudinally extending corrugations 13, such construction also tending to stiffen such intermediate portion of the fin structure. In some cases it may be desirable to further stiffen the fin element by depositing the material 11 along the intermediate portions of the fin structure comprising the corrugations 13, and in like manner, if desired, the intermediate portion of each fin element may be formed by similar corrugations whereby the spacing material extends substantially from one longitudinal edge of the fin member to the other.

In other cases it may be desirable to provide spacing material in the form of a plurality of discs or buttons rather than a continuous block of material, this being particularly true where a conventional type of fin is

employed having tube holes instead of slots extending to the fin edge, and wherein the spacing material may encircle the tube hole.

The invention thus provides a reinforcing means adapted to maintain the fin structure in its desired shape and at the same time, where desired, to provide means for accurately spacing the assembled fin elements.

Obviously, the invention is not limited to utilization merely with fin structures such as those illustrated in the drawings, but may be readily adapted to fin structures which because of their configuration or contour have heretofore been either difficult or substantially impossible to assemble in conventional jigs and fixtures, as well as fin structures embodying material of such light gauge that irrespective of shape, it likewise could not be utilized in conventional manufacturing jigs and fixtures. Likewise the present invention enables the production of a fin member which may be easily handled, assembled, etc., with substantially ordinary techniques.

While I have referred to thermo-plastic and water soluble materials, it is believed apparent that if desirable other materials may be employed in the event they provide the desired rigidity, may be easily removed from the structure following the assembly thereof and will not unreasonably interfere with the bonding operations.

Having thus described my invention, it is obvious that various immaterial modifications may be made in the same without departing from the spirit of my invention; hence, I do not wish to be understood as limiting myself to the exact form, construction, arrangement and combination of parts, or methods herein shown and described, or uses mentioned.

What I claim as new and desire to secure by Letters Patent is:

1. The method of fabricating a heat exchange structure utilizing a plurality of associated fin members of relatively thin sheet metal, comprising the following steps: suitably forming the sheet metal to provide fin members of the desired shape and size, adherably applying a material to a portion of such a fin member to form a coating thereon considerably greater in thickness than said sheet metal for spacing adjacent fin members, assembling said members in operative relation, operatively connecting the fin members with metallic tubular connecting means for heat transfer relationship, removing said material, and bonding said fin members and said metallic tubular connecting means into an integral assembly and in heat transfer relationship.

2. The method of fabricating a heat exchange structure utilizing a plurality of associated fin members of relatively thin sheet metal, comprising the following steps: suitably forming the sheet metal to provide fin members of the desired shape and size, adherably applying a material to a portion of such a fin member to form a coating thereon considerably greater in thickness than said sheet metal, assembling said members with said material in engagement with an adjacent fin member for spacing adjacent fin members, with said material limiting movement of said fin members toward each other, operatively connecting the fin members with metallic tubular connecting means for heat transfer relationship, removing said material, and bonding said fin members and said metallic tubular connecting means into an integral assembly and in heat transfer relationship.

3. The method of fabricating a heat exchange sturcture utilizing a plurality of associated fin members of relatively thin sheet metal, comprising the following steps: suitably forming the sheet metal to provide fin members of the desired shape and size, adherably applying a thermo-plastic material to such a fin member to form a coating thereon considerably greater in thickness than said sheet metal, assembling said members with the thermo-plastic material in engagement with an adjacent fin member with said material limiting movement of said fin members toward each other for spacing adjacent

fin members, operatively connecting the fin members with metallic tubular connecting means for heat exchange relationship, heating the assembly to melt said thermoplastic material and thereby remove the same, and bonding said fin members and metallic tubular connecting means into an integral assembly and in heat transfer relationship.

4. A method as defined in claim 3, wherein said thermoplastic material incorporates a bonding flux whereby upon removal of said material, said fluxing material is available prior to the bonding operation.

5. The method of fabricating a heat exchange structure utilizing a plurality of associated fin members of relatively thin sheet metal, comprising the following steps: suitably forming the sheet metal to provide fin members of the desired shape and size including offsetting a portion of each fin member to provide a depression in the face of the fin member adherably depositing in said depression a material which is solid under normal conditions, stacking said fin members with a succeeding fin member supported by the material carried by the preceding fin member for spacing adjacent fin members and the spacing of the fin members dependent upon the thickness of such material and with portions of said fin members being engaged with metallic tubular connecting means for heat transfer relationship, converting said material to such form that removal thereof from said depressions may be effected and removing the same therefrom, and bonding engaged portions of said fin members to said metallic tubular connecting means in heat exchange relationship.

6. The method of fabricating a heat exchange structure utilizing a plurality of associated fin members of relatively thin sheet metal, comprising the following steps: suitably forming the sheet metal to provide fin members of the desired shape and size, adherably depositing a material which is solid under normal conditions upon said members for spacing adjacent fin members, arranging said fin members in operative relation with similar members, operatively engaging metallic tubular connecting means with respective fin members for heat exchange relationship, converting said material to such form that removal thereof from said fin members may be effected and removing the same therefrom, and bonding engaged portions of said fin members to said metallic tubular connecting means in heat exchange relationship.

7. The method of fabricating a heat exchange structure utilizing a plurality of associated fin members of relatively thin sheet metal, comprising the following steps: suitably forming the sheet metal to provide fin members of the desired shape and size, adherably applying a layer of material which is a solid under normal conditions, stacking said fin members with a succeeding fin member supported by the material carried by the preceding fin member for spacing adjacent fin members and the spacing of the fin members dependent upon the thickness of said layer of material, and with portions of said fin members being engaged with metallic tubular connecting means for heat transfer relationship, converting said material to such form that removal thereof from the fin member may be effected and removing the same therefrom, and bonding engaged portions of said fin members to said metallic tubular connecting means in heat transfer relationship.

8. The method of fabricating a heat exchange structure utilizing a plurality of associated fin members of relatively thin sheet metal, comprising the following steps: suitably forming the sheet metal to provide fin members of the desired shape and size including transversely offsetting a portion of each fin member to provide a longitudinally extending depression in the face of the fin member, adherably depositing a thermo-plastic material which is a solid under normal conditions, in said depression to completely fill the same, stacking said fin members with a succeeding fin member supported by the material carried by the preceding fin member for spacing adjacent fin members and the spacing of the fin members dependent upon the thickness of said layer of material, engaging portions of said fin members with metallic tubular connecting means for heat exchange relationship, applying heat to the assembly to melt said material to effect removal thereof from said fin member, and bonding engaged portions of said fin members to said metallic tubular connecting means.

9. In fabricating a heat exchange structure, the combination of a plurality of fluid conducting tubes, a plurality of fin members extending transversely relative to and in operative engagement with said tubes, said fin members each having an offset portion with said offset portions being similarly positioned, removable material affixed within the offset portions of each of said fin members, and each of said fin members adapted to cooperate with one another when filled with said removable material to operatively space said fin members during assembly thereof.

10. As an article of manufacture, a fin member for fabricating heat exchangers, comprising a body portion formed from sheet metal and a removable material in the form of a solid under normal conditions, adherably applied to said member, operative to provide increased resistance to deformations in said fin member during handling thereof, and said material adapted to be removed therefrom following assembly of the fin member with other elements of a heat exchange structure.

11. As an article of manufacture, a fin member for fabricating heat exchangers, said fin member of very thin sheet metal and having relatively little deformation resistance and adapted to be associated with other fin members and bonded to means operatively connecting the same to form an integral assembly, and a body of material which is relatively rigid under normal room temperatures and conditions adherably associated with a peripheral face of said fin member and operative to restrict deformation of the member, and the aforesaid body of material providing means for operatively spacing like fin members when stacked one upon the other.

12. As an article of manufacture, a fin member for fabricating heat exchangers, said fin member of very thin sheet metal and having relatively little deformation resistance and adapted to be associated with other fin members and bonded to means operatively connecting the same to form an integral assembly, and a body of material which is relatively rigid under normal room temperatures and conditions adherably associated with a peripheral face of said fin member and operative to restrict deformation of the member, and the aforesaid body of material providing means for operatively spacing like fin members when stacked one upon the other, said material being adapted to be connected when subjected to predetermined conditions, and in such form that it may be readily removed from fin members so stacked.

13. A fin member for fabricating heat exchangers as defined in claim 11, wherein said fin member is formed with a depression therein, said material being positioned in said depression with the latter forming a receptacle therefor.

14. As an article of manufacture, a fin member for heat exchange structures comprising a body portion formed from sheet material, said fin member having a non-planar transverse cross-section, and a removable material adherably applied to said fin member and adapted to cooperate with contiguous abutting portions of another fin member during assembly thereof to effect a predetermined spacing of adjacent fin members.

15. As an article of manufacture, a fin member for a heat exchanger including a plurality of stacked fin members and other heat exchange elements, said fin member comprising a body portion formed from sheet metal, a removable and stiffening material in the form of a solid under normal conditions in one physical phase, adherably

applied to said member, said removable and stiffening material operative to provide increased resistance to deformations in said fin member during handling thereof, and said removable and stiffening material adapted in another physical phase to be removed therefrom under predetermined conditions for said last-mentioned physical phase, said removable and stiffening material permitting said fin member to be readily assembled with other fin members of the heat exchanger to a predetermined stack of fin members for said heat exchanger, each of said fin members during stacking supported and spaced from a contiguous fin member by said removable and stiffening material.

16. A heat exchange structure comprising a plurality of assoicated fin members of foil-like sheet metal and tubular heat exchange members, each of said fin members provided with tube-receiving openings arranged in longitudinally extending rows, each of said fin members having a predetermined shape and size and including a transversely offset portion providing a longitudinal turbulence producing means in a face of the fin member, a layer of removable material which is in a solid physical phase under normal conditions adherably applied within said turbulence producing means to completely fill said means for stiffening said fin member, said associated fin members stacked with a succeeding contiguous member supported by the removable material of the preceding member so that the spacing of said fin members is a function of the thickness of said removable material, each of said tube-receiving openings of the stacked fin members including peripheral formed means for operatively engaging the tubular heat exchange members assembled therein, so that upon the bonding of said tubular heat exchange members to the stacked fin members, the layer of removable material for each fin member is disintegrated leaving the fin members spaced a predetermined distance apart.

17. A heat exchange structure as set forth in claim 16, wherein said turbulence producing means of each of the fin members is a longitudinally extending channel therein comprising a bottom and outwardly diverging side walls, and said removable material positioned within said channel.

18. A heat exchange structure as set forth in claim 16, whereby said removable material provides stiffening means for each of the fin members formed from foil-like sheet metal.

19. A heat exchange structure as set forth in claim 16, wherein a peripheral edge of each of said fin members comprises longitudinally extending corrugations in addition to said transversely offset portion for providing additional turbulence producing means and for stiffening said fin members.

20. A heat exchange structure as set forth in claim 19, wherein similar removable material provides stiffening means for the longitudinally extending corrugations of each of the fin members formed from foil-like sheet metal.

21. A heat exchange structure as set forth in claim 16, wherein said removable material for each of the fin members provides spacing means to maintain proper distance between the fins as the heat exchanger structure is fabricated.

22. A heat exchange structure as set forth in claim 16, wherein said removable material includes a fluxing material so that the residue remaining on the heat exchange structure after the major portion of the removable material is disintegrated provides a flux for bonding of said tubular heat exchange members to the stacked fin members.

23. As an article of manufacture, a fin member for a heat exchange structure comprising a body portion formed from foil-like sheet metal and provided with tube-receiving openings arranged in longitudinally extending rows, said fin member having a predetermined shape and size and including a transversely offset portion providing a longitudinal turbulence producing means in a face of the fin member, a layer of removable material which is in a solid physical phase under normal conditions adherably applied within said turbulence producing means to completely fill said means for stiffening said fin member, so that in stacking a plurality of fin members, said associated fin members are stacked with a succeeding contiguous member supported by the removable material of the preceding member, whereby the spacing of contiguous stacked fin members is a function of the thickness of said removable material.

24. As an article of manufacture, a fin member for a heat exchange structure as set forth in claim 23, wherein said removable material is meltable.

25. As an article of manufacture, a fin member for a heat exchange structure as set forth in claim 23, wherein said removable material is dissolvable.

26. As an article of manufacture, a fin member for a heat exchange structure as set forth in claim 23, wherein a fluxing material is added to the removable material.

27. As an article of manufacture, a fin member for a heat exchange structure as set forth in claim 23, wherein said removable material is adapted to stiffen said fin member by increasing the transverse cross-section of said fin member intermediate the longitudinal edges thereof.

28. As an article of manufacture, a fin member for a heat exchange structure as set forth in claim 23, wherein said removable material is subject to disintegration under predetermined physical changes from a solid phase to a fluid phase.

29. As an article of manufacture, a fin member for a heat exchange structure as set forth in claim 23, wherein said removable material from its predetermined solid state is flowable at temperatures at which the fin members are fabricated into a heat exchange structure by bonding.

References Cited in the file of this patent

UNITED STATES PATENTS

1,060,361	Rea	Apr. 29, 1913
1,920,313	Mautsch	Aug. 1, 1933
1,927,325	Ritter	Sept. 19, 1933
2,006,649	Modine	July 2, 1935
2,055,549	Modine	Sept. 29, 1936
2,055,838	Fritzberg	Sept. 29, 1936
2,072,652	Shafner	Mar. 2, 1937
2,252,211	Seemiller	Aug. 12, 1941
2,360,479	Detrick et al.	Oct. 17, 1944
2,413,731	Samuel	Jan. 7, 1947
2,415,412	Buchwald et al.	Feb. 11, 1947
2,430,083	Sherman	Nov. 4, 1947
2,834,583	Oldberg	May 13, 1958

FOREIGN PATENTS

633,229	France	Oct. 22, 1927