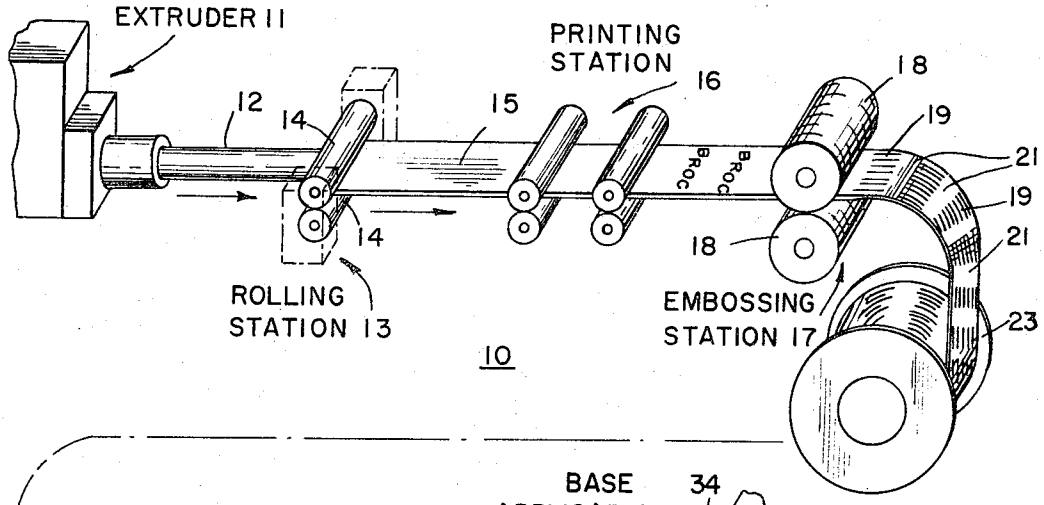
Sept. 17, 1968 M. L. ANTHONY 3,401,826

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FIG. 1



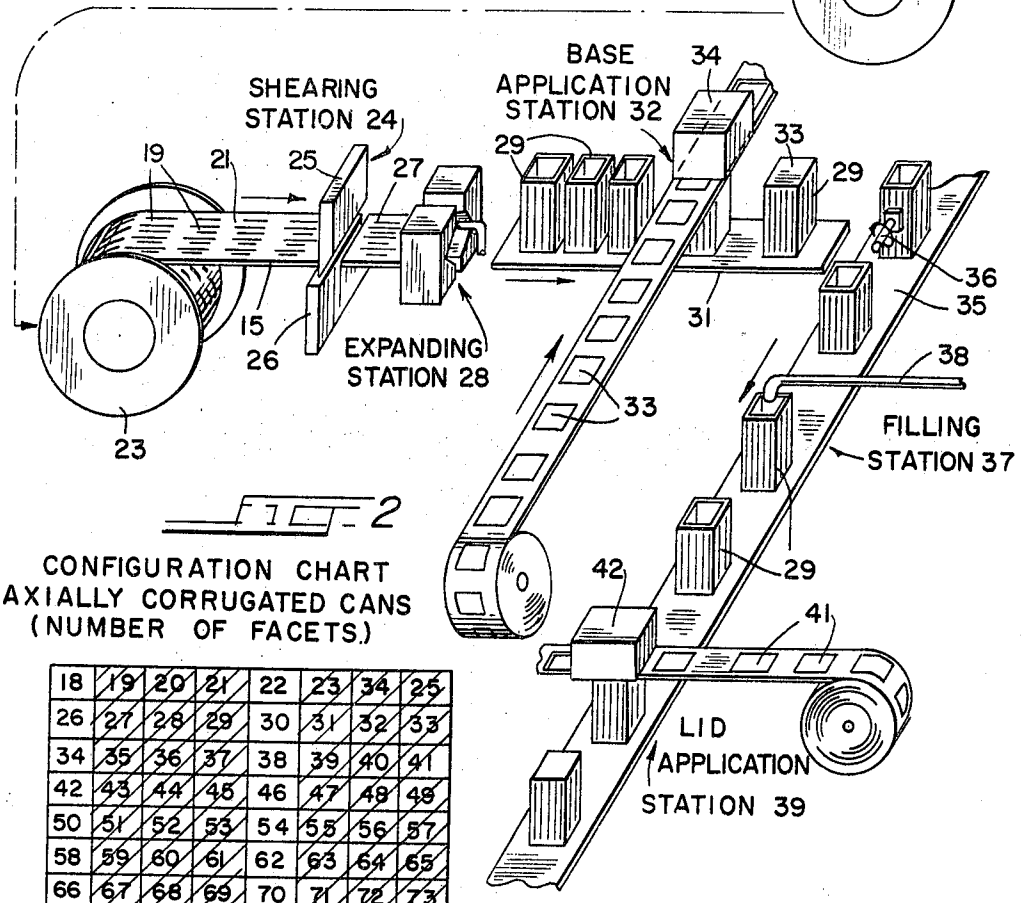


FIG. 2

CONFIGURATION CHART
AXIALLY CORRUGATED CANS
(NUMBER OF FACETS)

18	19	20	21	22	23	34	25
26	27	28	29	30	31	32	33
34	35	36	37	38	39	40	41
42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57
58	59	60	61	62	63	64	65
66	67	68	69	70	71	72	73
74	75	76	77	78	79	80	81
82	83	84	85	86	87	88	89
90	91	92	93	94	95	96	97
98	99	100	101	102	103	104	105
51	52	53	54	55	56	57	58

INVENTOR.
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Fig. 3

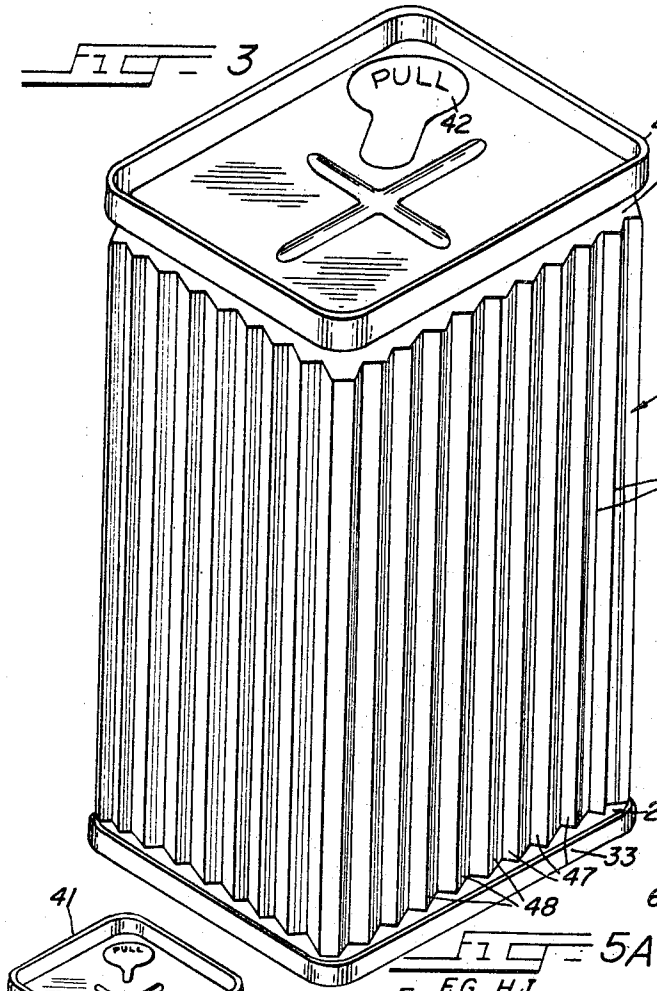


Fig. 4

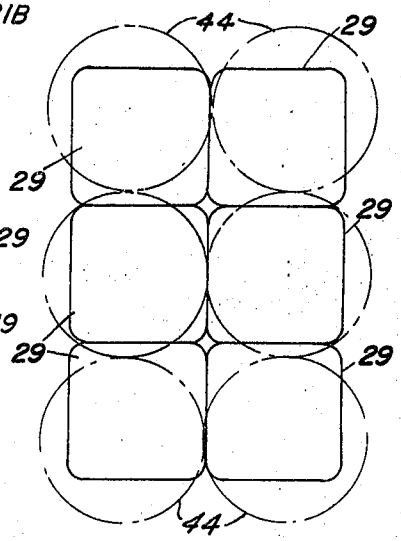


Fig. 3A

Fig. 5A

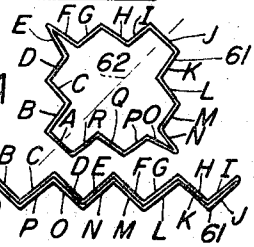


Fig. 6

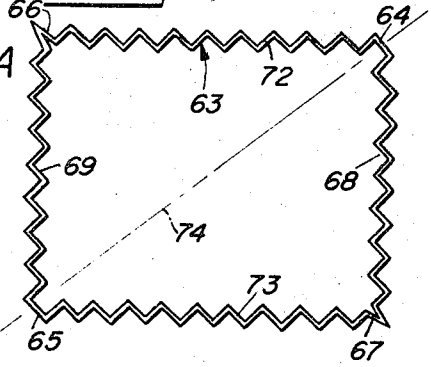


Fig. 7

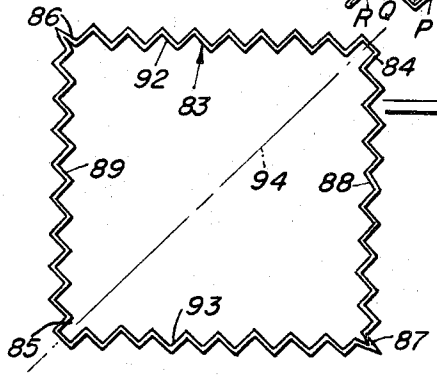


Fig. 5B

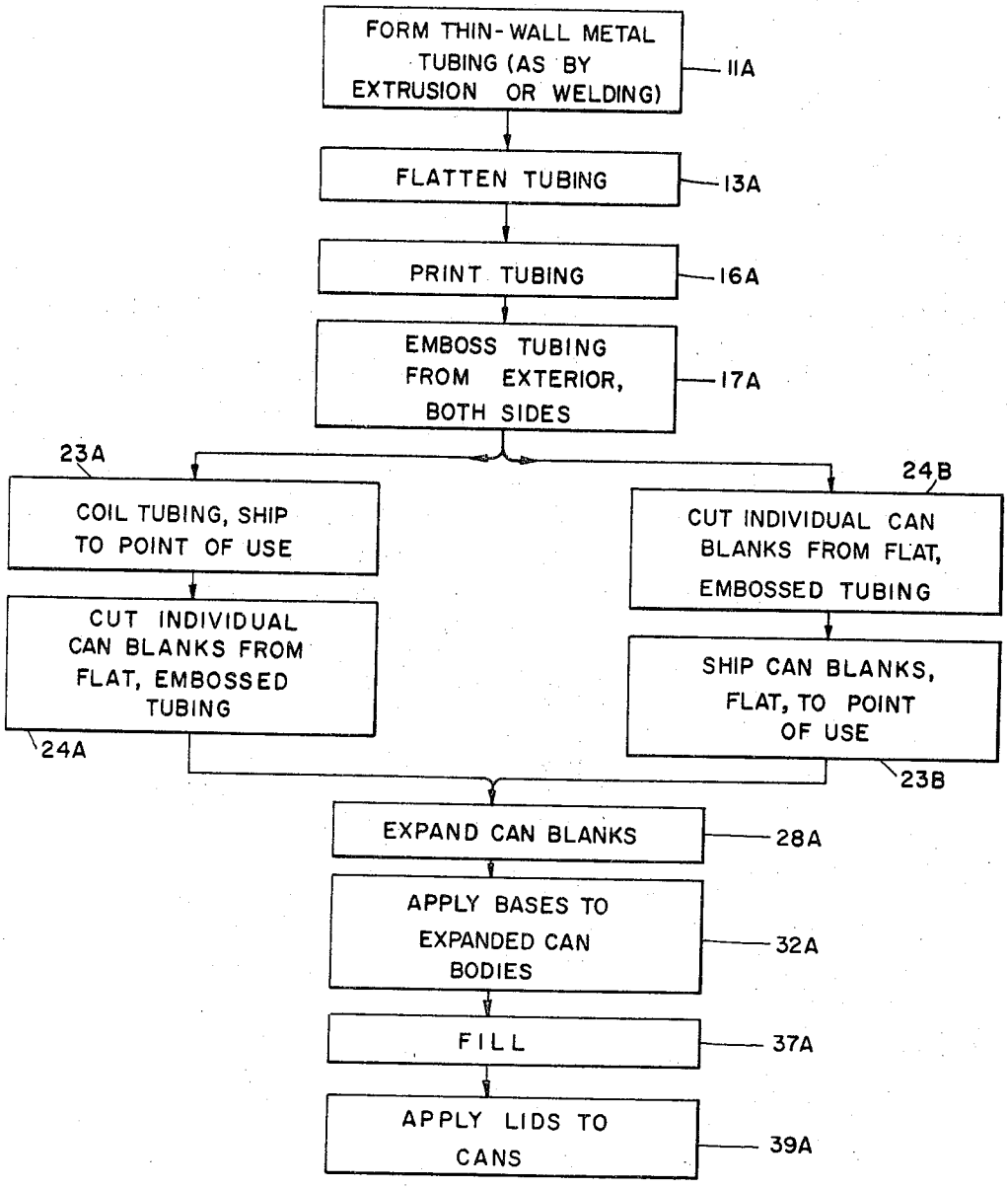
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Fig. 8



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PACKAGING SYSTEM

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FIG. 9

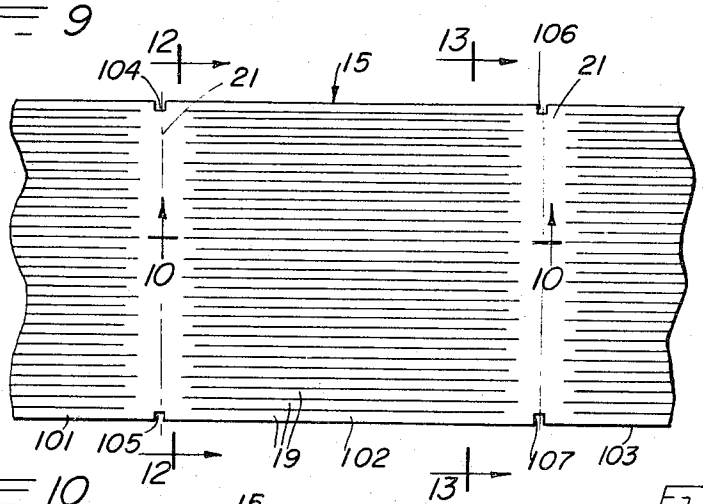


FIG. 10

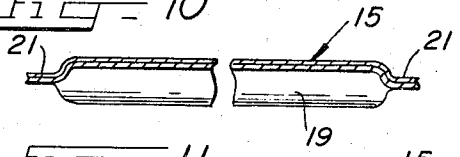


FIG. 12

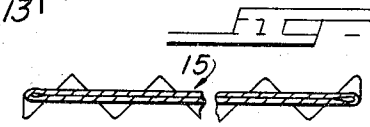


FIG. 11

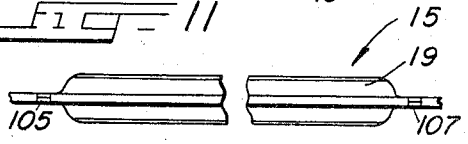


FIG. 13

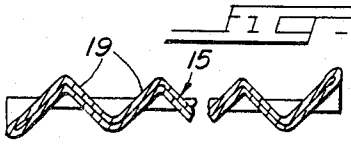


FIG. 14

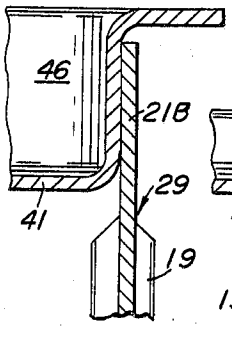


FIG. 15

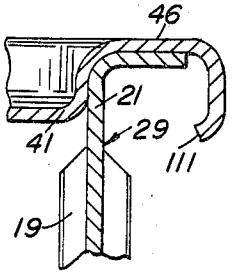


FIG. 16

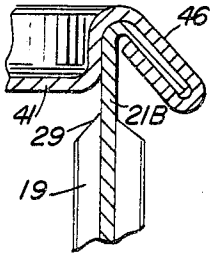
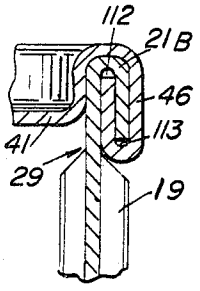


FIG. 17



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Fig. 18

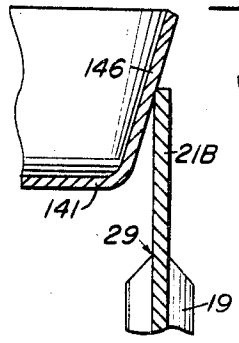


Fig. 19

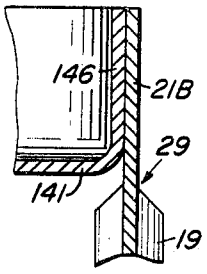


Fig. 20

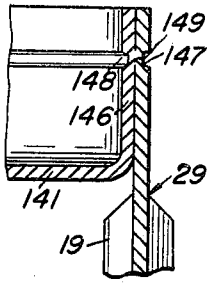


Fig. 21

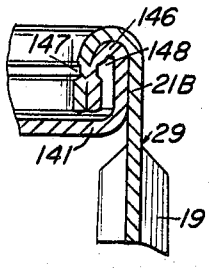


Fig. 22

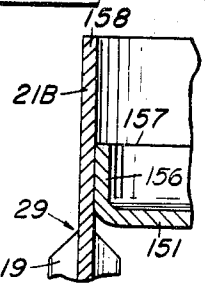


Fig. 23

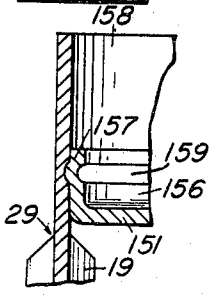


Fig. 24

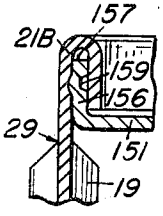


Fig. 25

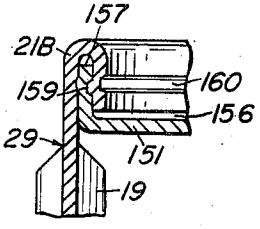


Fig. 26

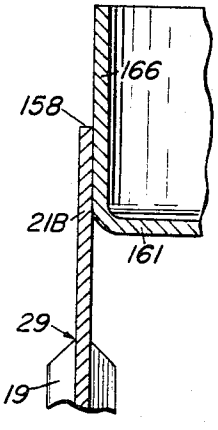


Fig. 27

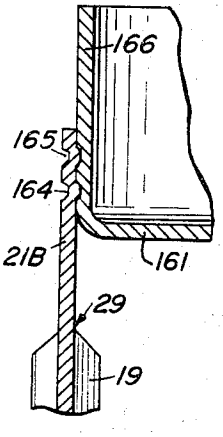


Fig. 28

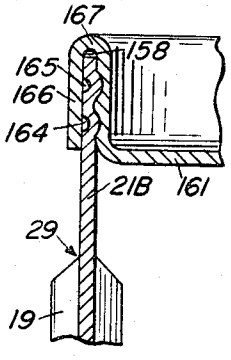
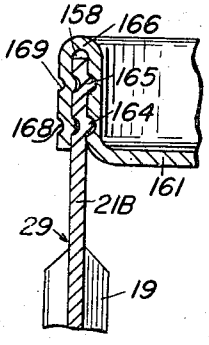


Fig. 29



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FIG. 30

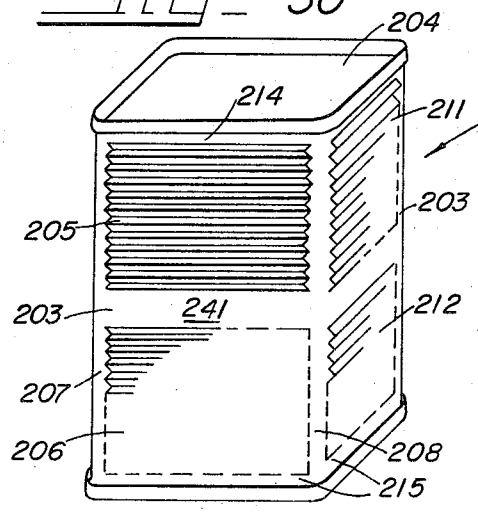


FIG. 31

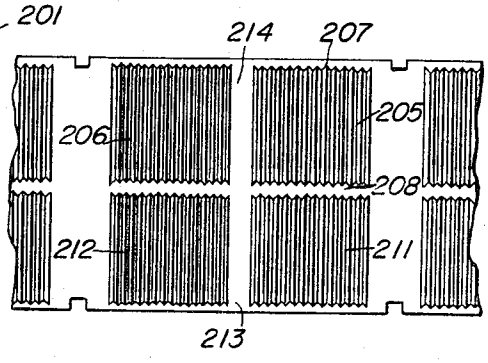


FIG. 32

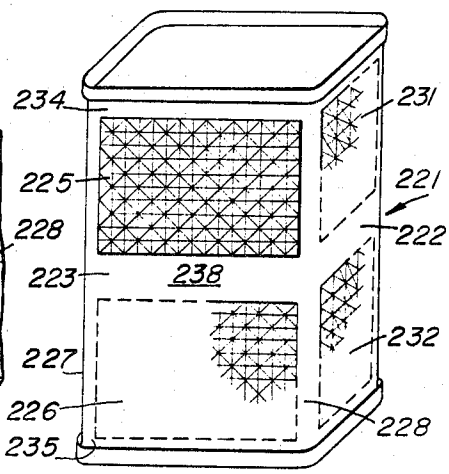


FIG. 33

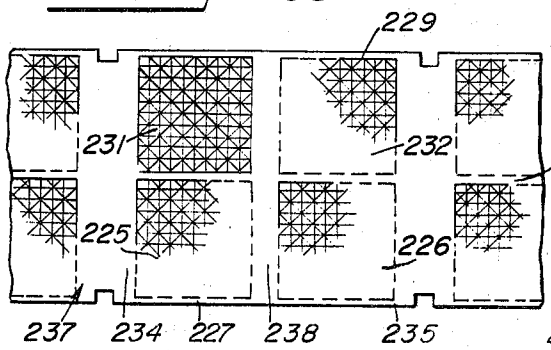


FIG. 34

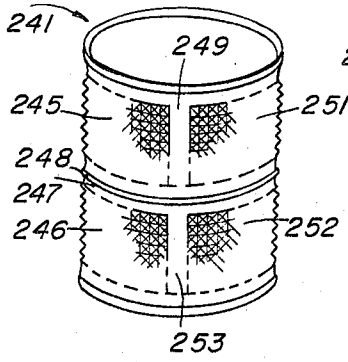


FIG. 35

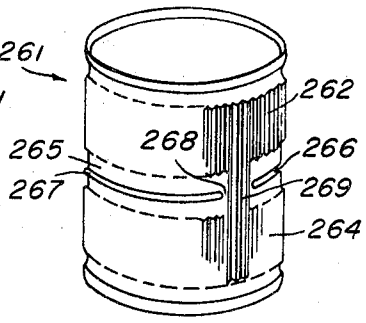
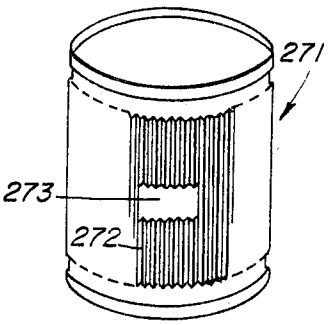


FIG. 36



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Fig. 37

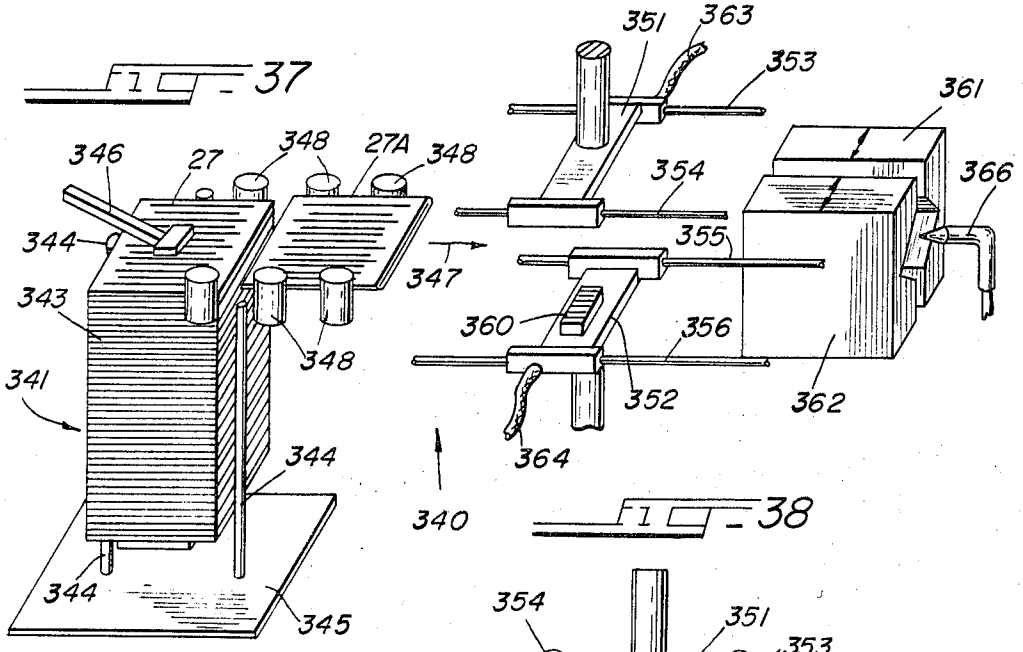


Fig. 38

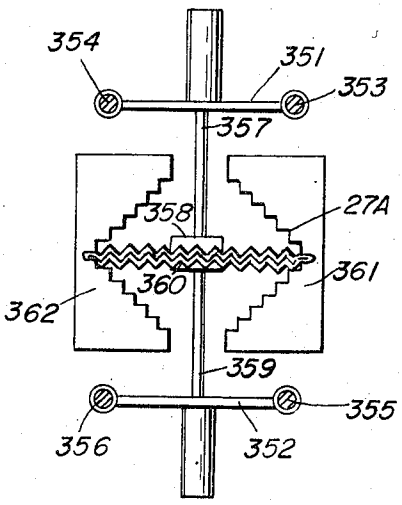


Fig. 39

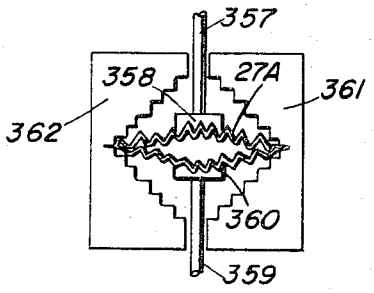
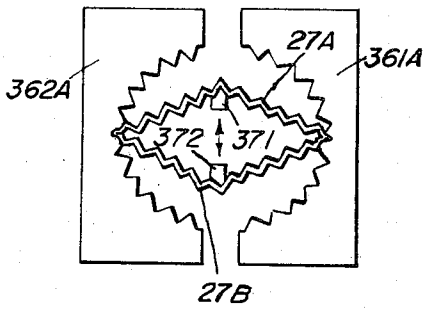
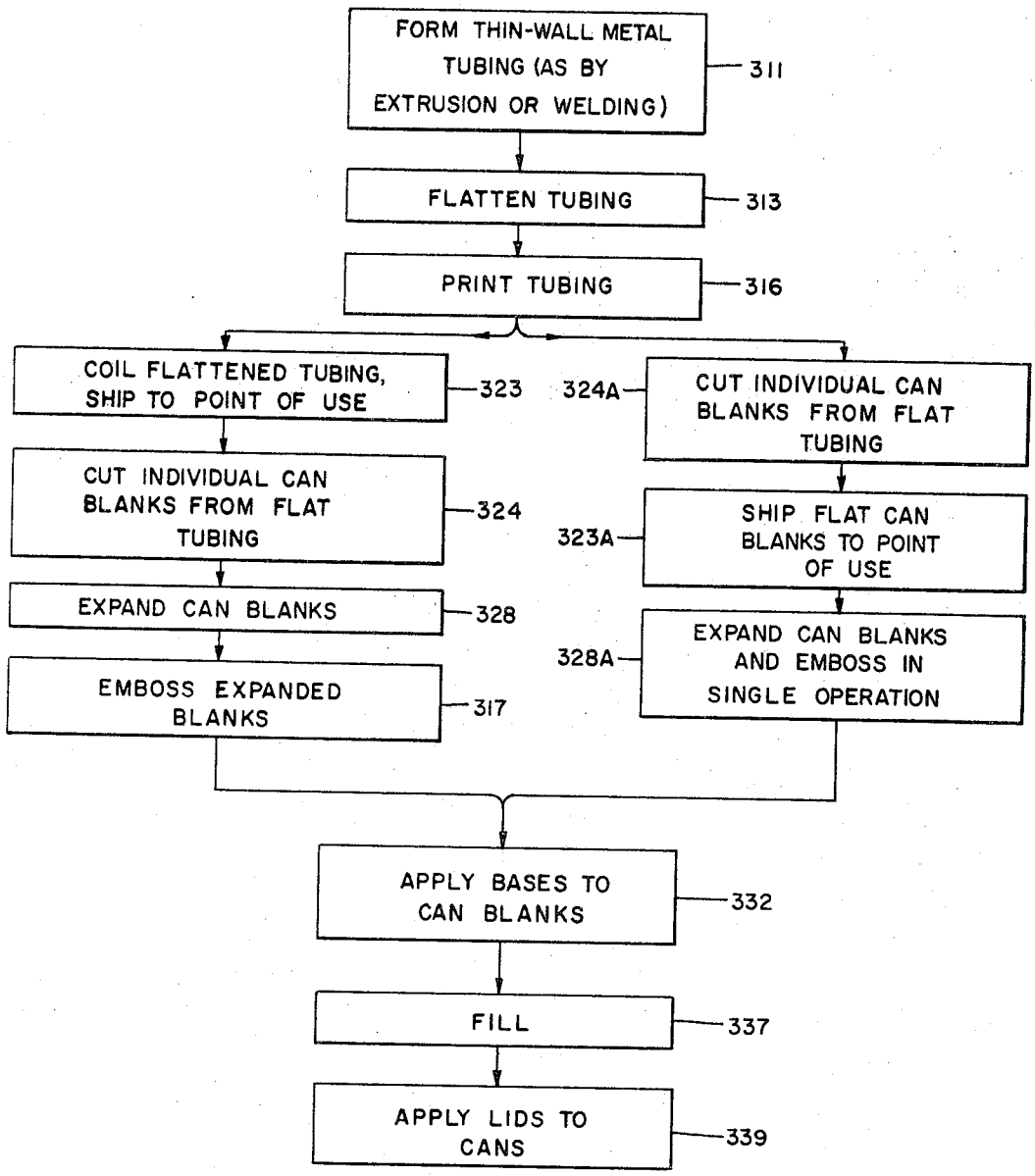


Fig. 40



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Fig. 41



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Fig. 42

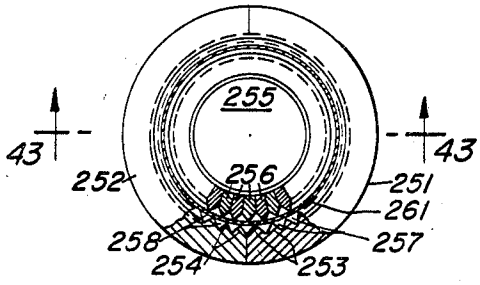


Fig. 44

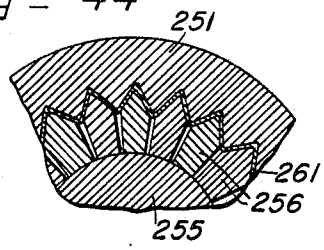


Fig. 43

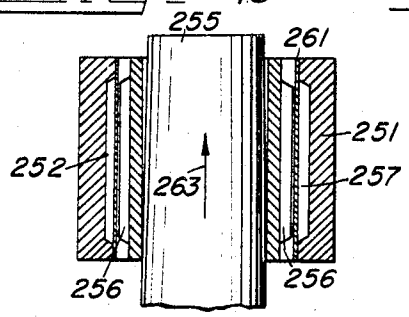


Fig. 45

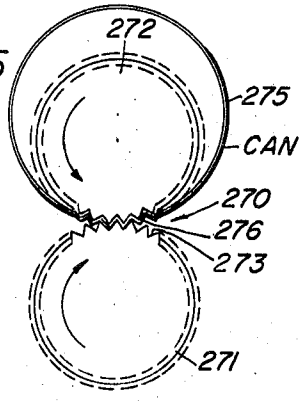


Fig. 46

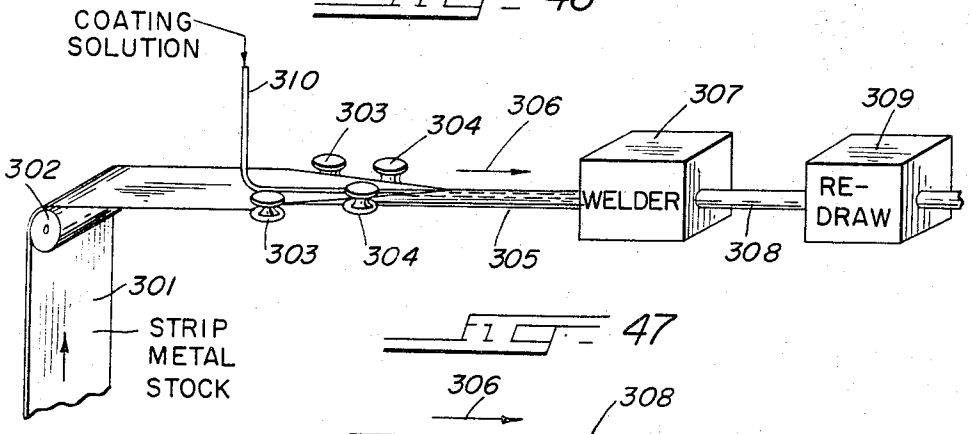
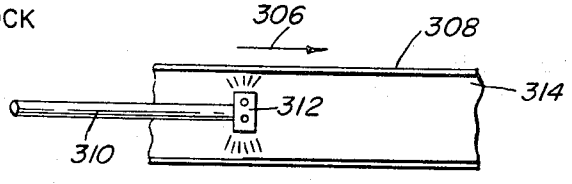


Fig. 47



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United States Patent Office 3,401,826
Patented Sept. 17, 1968

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PACKAGING SYSTEM

Myron L. Anthony, La Grange, Ill., assignor of twenty-five percent each to George W. Butler and Gladys A. Butler, both of River Forest, and five percent to Thomas E. Dorn, Clarendon Hills, Ill.

Filed Jan. 5, 1965, Ser. No. 423,497
13 Claims. (Cl. 220—72)

ABSTRACT OF THE DISCLOSURE

High-strength thin-wall metal can blanks and cans, and methods of forming and sealing the can blanks and cans. The can blanks, in one embodiment, are fabricated in substantially completely flattened tubular form with either longitudinal or transverse flat-faced corrugations throughout most of the surface area of the blank. The longitudinal edges of the can blanks terminate in relatively flat reverse bends. For longitudinally corrugated cans, the blanks have an even number of corrugation facets and an odd integral number of pairs of facets to permit expansion of the blank into a rectangular can body symmetrical about a transverse longitudinal plane. Commercial meessages or other identification data are printed or otherwise reproduced on the corrugations, in registry therewith, to display messages of variant form depending on the angle from which the can is viewed. The longitudinal ends of the cans are left free of corrugations to permit effective hermetic sealing.

This invention relates to a new and improved packaging system. More particularly, the invention pertains to a packaging system which incorporates novel hermetically sealed can structures, novel methods of fabricating hermetically sealed cans and similar containers, and unique filling and distribution techniques employed in conjunction therewith. The invention is especially advantageous as applied to the manufacture and utilization of hermetically sealed thin-wall metal cans, particularly aluminum cans, although other materials may also be utilized as described more fully hereinafter.

The conventional "tin can," in its many structural forms, is perhaps the most prevalent type of package employed for foods, beverages, semi-liquid and liquid materials, and for other materials, such as granulated coffee, which require hermetic sealing during shipment and storage. The can is fabricated from thin gauge sheet steel which has been plated with tin or has been otherwise provided with a protective coating. The can body is usually fabricated in cylindrical form, most frequently of circular cross section, with a base sealed to one end of the cylinder. This body is then filled and a lid is sealed to the top of the can to complete the package.

In some instances, the conventional tinplate can is fabricated from appropriately coated sheet steel at the point of use. This technique, however, is economically practical only for large canning operations. For packaging plants having a moderate or relatively small volume, the investment required for can-manufacturing machinery is prohibitive. Consequently, plants of small and moderate size, which are much more numerous than really large canning installations, employ prefabricated can bodies which require only filling followed by crimping or other sealing of a lid onto the can body to complete the package. Thus, it is frequently necessary to ship relatively large quantities of empty cans from the manufacuring point to the point of use, a quite wasteful procedure.

Conventional tinplate cans are not satisfactory for the packaging of some products, particularly those products which may be adversely affected by contact with iron

through any pores or other imperfections in the tinplate. This is particularly true with respect to alcoholic beverages such as beer, which spoil rapidly upon contact with iron. Beer cans fabricated from sheet steel require specialized protective coatings, usually resin coatings, to prevent contact between the can body and the contents of the can. Even with this resin coating technique, which is itself rather expensive, canned bear cannot be stored indefinitely but must be rotated in the warehouse stock because it will ultimately spoil through penetration of the protective coating. The capital equipment necessary for the manufacture of beer cans is elaborate and expensive and in commercial practice is limited to only a few locations. Consequently, large shipments of empty cans are required from the manufacturing points to the breweries or other canning installations.

Aluminum cans have been proposed for food packaging, for beer containers, and for other uses. Generally speaking, however, aluminum cans have been adopted commercially only in rather specialized applications because the amount of aluminum required for construction of a can that will withstand the same usage as a conventional tinplate can make the aluminum cans excessively expensive. Thus, despite the fact that aluminum cans have minimal adverse effect upon alcoholic beverage such as beer, there has been only a quite limited use of aluminum beer cans. Moreover, the fabrication of cans and like containers from aluminum using conventional techniques still results in the expense of shipping empty containers from the point of manufacture to the cannery or other plant at which they are used.

It is a principal object of the present invention, therefore, to provide novel container structures and unique fabrication methods making it possible to ship prefabricated hermetically sealable can blanks in flattened compact form from point of manufacture to a cannery, brewery, or other location at which the containers are expanded, filled and sealed.

Another object of the invention is to afford a practical means for increasing the effective strength of a hermetically sealable can of thin metal so that it may be substituted for a conventional can without substantial loss of structural strength.

A related object of the invention is to provide a corrugated can construction making it possible to construct a thin-wall aluminum container having essentially the same structural characteristics and strength as a conventional tinplate can.

A corollary object of the invention to provide a corrugated can structure affording maximum strength for minimum wall thickness, using aluminum, plated steel, or other metals in thicknesses ranging down to gauges usually considered as representing foil unusable for rigid can structures.

A further object of the invention is to provide a practical packaging system that permits shipment of a multiplicity of flattened hermetically sealable container blanks in nested relation with each other so as to require a minimum of shipping space.

A particular feature of the invention is the provision for unique geometrical relationships in corrugations in the can blanks that facilitate flat, nested shipment and further enable the fabrication of a variety of rectangular, elliptical or circular can bodies from a single form of prefabricated can blank.

Another object of the invention is to afford a new and improved continuous process for manufacturing hermetically sealable cans from seamless metal tubing, including aluminum tubing.

An additional object of the invention is to provide for prefabrication of hermetically sealable container blanks

in continuous roll form so that a large number of cans may be fabricated from a single roll of prefabricated container blanks.

Another object of the invention is to provide for convenient and rapid erection of a can body that has been shipped in the form of a flattened blank, at a location where the can is to be filled, by inexpensive apparatus of a low order of complexity.

A specific object of the invention is to afford a practical economical aluminum can structure especially suitable for the packaging of beverages and specifically including alcoholic beverages.

A further specific object of the invention is to afford a unique corrugated can structure providing a smooth transition from the body of the can to the base and the lid of the can so that the corrugated construction does not interfere with hermetic sealing.

A fundamental object of the invention is to provide a continuous can manufacturing process that may be accomplished with relatively simple and inexpensive machinery and that reduces costs with respect to shipment and storage of prefabricated cans prior to use and also reduces shipping and storage costs for the completed filled cans.

Yet another object of the invention is to provide a new and improved can structure having markedly improved heat transfer characteristics as compared to conventional tinplate cans.

A further object of the invention is to provide a new and improved technique for uniformly coating the interior surfaces of metal cans and like hermetically sealed containers formed from severed segments of a continuous tube.

Still another object of the invention is to provide improved methods and means for mounting can lids and bases on can bodies to afford a good hermetic seal of satisfactory mechanical strength at minimum cost.

Other and further objects of the present invention will be apparent from the following description and claims and are illustrated in the accompanying drawings which, by way of illustration, show preferred embodiments of the present invention and the principles thereof and what is now considered to be the best mode contemplated for applying these principles. Other embodiments of the invention embodying the same or equivalent principles may be made as desired by those skilled in the art without departing from the present invention.

In the drawings:

FIG. 1 is a simplified perspective schematic illustration of a packaging system comprising one embodiment of the present invention;

FIG. 2 is a chart illustrating preferred corrugation geometry for one form of the present invention utilized in the fabrication of rectangular cans;

FIG. 3 is a perspective view of a hermetically sealed vertically corrugated rectangular can fabricated in accordance with one embodiment of the invention and based upon the geometry chart of FIG. 2;

FIG. 3A is a detail perspective view illustrating a lid for the can of FIG. 3;

FIG. 4 illustrates a plurality of filled cans in nested arrangement ready for shipping;

FIGS. 5A and 5B illustrate one form of can blank constructed in accordance with the present invention in expanded and in collapsed form, respectively;

FIG. 6 illustrates a particular can blank constructed in accordance with the present invention after erection to afford a cylindrical can body of rectangular cross-section;

FIG. 7 illustrates the same container blank as FIG. 6 but erected to afford a cylindrical can body of square cross-sectional configuration;

FIG. 8 is a flow chart illustrating the method of the present invention pertaining to the embodiment of the packaging system illustrated in FIG. 1;

FIG. 9 is a plan view of a strip of flattened can bodies produced at an intermediate stage in the system of FIG. 1;

FIG. 10 is a longitudinal section view taken approximately along line **10—10** in FIG. 9;

FIG. 11 is an edge view of a portion of the flattened corrugated strip of can blanks of FIG. 9;

FIG. 12 is a transverse sectional view taken approximately along line **12—12** in FIG. 9;

FIG. 13 is a transverse sectional view taken approximately along line **13—13** in FIG. 9;

FIGS. 14, 15, 16 and 17 are detail sectional views illustrating successive stages in one process for sealing a lid onto a can or like package constructed in accordance with the present invention;

FIGS. 18, 19, 20 and 21 are detail sectional views illustrating successive stages in the sealing of a lid onto a can or like package constructed in accordance with the present invention and utilizing a different technique from that illustrated in FIGS. 14–17;

FIGS. 22, 23, 24 and 25 are detail sectional views illustrating successive stages in the sealing of a lid (or base) into a can or like package in accordance with another feature of the present invention;

FIGS. 26, 27, 28 and 29 are detail sectional views illustrating yet another technique employed for sealing lids and bases into cans constructed in accordance with the present invention;

FIG. 30 is a perspective illustration of another form of hermetically sealed can fabricated in accordance with the invention;

FIG. 31 is a plan view of an embossed strip of can blanks produced at an intermediate stage in the manufacture of the can illustrated in FIG. 30;

FIG. 32 is a perspective view of another form of hermetically sealed can constructed in accordance with the invention;

FIG. 33 is a plan view of an embossed strip of can blanks produced at an intermediate stage in the manufacture of cans of the kind shown in FIG. 32;

FIGS. 34, 35 and 36 are perspective views of additional embodiments of hermetically sealed cans constructed in accordance with the present invention;

FIG. 37 is a simplified schematic perspective view of apparatus for expanding a flattened tubular can body blank to usable form;

FIG. 38 is a detail view of the can-forming dies of the apparatus of FIG. 37 at an initial stage of their operation;

FIG. 39 illustrates the apparatus of FIG. 38 at a subsequent stage of operation;

FIG. 40 illustrates a modification of the can expansion apparatus of FIGS. 38 and 39;

FIG. 41 is a flow chart illustrating another embodiment of the method of the present invention;

FIG. 42 is a sectional view of one form of embossing apparatus that may be utilized in the present invention, particularly in conjunction with the method of FIG. 41;

FIG. 43 is a sectional view taken approximately as indicated by line **43—43** in FIG. 42;

FIG. 44 is a detail sectional view illustrating the final operating position for the apparatus of FIGS. 42 and 43;

FIG. 45 illustrates another form of embossing apparatus that may be utilized in carrying out the method of FIG. 41;

FIG. 46 is a schematic perspective view illustrating a method of applying a coating solution to the interior surface of a continuous tube utilized in fabricating cans in accordance with the present invention; and

FIG. 47 is a detail sectional view of a portion of the apparatus of FIG. 46.

Packaging system I

FIG. 1 illustrates a packaging system **10** for manufac-

turing hermetically sealed cans in accordance with one embodiment of the present invention; this same embodiment is illustrated in the flow chart of FIG. 8. Packaging system **10** (FIG. 1) may start with an extruding apparatus **11** of conventional construction that produces a continuous seamless metal tube **12**. The metal tube **12** need not be of circular cross-sectional configuration. However, in order to assure uniformity in thickness of the tube walls, circular-section tubing is usually desirable. Extruder **11** need not be physically incorporated in the system **10**; fabrication of the hermetically sealed cans to be produced by the system may be initiated with seamless tubing purchased from a commercial source of supply. Aluminium tubing is preferred, but other thin-wall tubing may be employed, including tubing fabricated by welding or other techniques from flat strip.

In the initial portion of packaging system **10**, metal tubing **12** is passed through a rolling station **13**. Rolling station **13** is provided with one or more pairs of rollers **14** which engage the tubing **12** and flatten the tubing as completely as possible. It should be understood that rolling station **13** may include several pairs of rollers or like flattening devices and that the transformation of the tubing **12** into the flattened strip **15** may be accomplished gradually in order to avoid undue deformation of the tubing walls, which might interfere with subsequent expansion of the tubing to the final form desired for the completed cans or might create weak spots in the cans. The flattening rollers may be relieved slightly at their ends to avoid undue deformation of the edges of the flattened strip **15**. Evenly spaced indexing notches are also formed in the edges of strip **15**, in rolling station **13**, as described hereinafter.

From rolling station **13**, the flattened metal tubing **15** is passed through a printing station **16**. At the printing station **16**, successive longitudinal sections of the flattened tubing **15**, defined by the indexing notches in the strip (see FIG. 9) are imprinted with identification data for the completed cans. The imprinted data may include advertising messages and pictures as well as appropriate information indicating the utimate contents of the cans. The length of the flattened tubing **15** assigned to each imprinted section may vary, depending upon the desired ultimate height of the cans. The printing apparatus incorporated in station **15** may be of conventional character and may be essentially similar to the corresponding apparatus employed to imprint conventional tinplate cans.

From printing station **16**, the flattened and imprinted metal tubing **15** is passed through an embossing station **17**. In FIG. 1, embossing station **17** is shown as including a pair of opposed embossing rolls **18** which engage the opposite sides of the flattened metal tube. It should be understood that more than one pair of embossing rolls may be required, inasmuch as embossing station **17** is utilized to produce, in the flattened tube **15**, a plurality of distinct corrugations of substantial depth. In FIG. 1, the corrugations **19** are shown as relatively long longitudinal corrugations, but other strengthening deformations of the flattened strip may be utilized as described hereinafter. Corrugations **19**, as shown in FIG. 1, do not extend continuously along the length of the flattened tubular strip **15**. Instead, each individual can length or blank on the strip **15** is embossed with the corrugations, leaving uncorrugated transverse sections **21** between each of the can lengths.

It is not necessary to employ roll-type embossing equipment to form the corrugations **19**, although this kind of embossing apparatus is usually preferable for high-volume continuous manufacture. A press-type embossing device may be utilized if desired. Regardless of the form of embossing apparatus used, care should be exercised to avoid significant contraction of strip **15** in width; the corrugations are achieved by stretching the metal.

From embossing station **17**, the flat, embossed, imprinted trip **15** is wound upon a drum **23**.

Most of system **10** as described above, comprising rolling station **13**, printing station **16** and embossing station **17**, is usually located at a central can manufacturing plant. From the manufacturing location, the strip of can blanks is shipped, on drum **23**, to a cannery, brewery, or other location at which the cans are to be used. At the cannery, strip **15** is unwound from drum **23** and is fed to a shearing station **24** that includes suitable shearing apparatus such as a reciprocating shear blade **25** working against an anvil **26**. Shearing blade **25** is actuated to sever the flattened tubular strip **15** at each unembossed intermediate section **21**, producing a series of flat can body blanks such as the blank **27**.

The next station **28** in system **10** expands each of the can body blanks **27** into a can body of cylindrical configuration. Throughout this specification and in the appended claims the terms "cylinder" and "cylindrical" are employed in the broad sense as referring to a configuration generated by movement of a stranght line in a closed path about a parallel straight line, hence including cylinders of rectangular, square, elliptical and other cross-sectional configurations as well as of circular configuration. Expanding station **28** is described more fully hereinafter in conjunction with FIGS. 29–31. In system **10**, the individual can body blanks are expanded to rectangular cylindrical form as shown by the can bodies **29**.

The expanded can bodies **29** are moved along a conveyor **31** to a base station **32**. At base station **32**, a strip of preformed can bases **33** is brought into alignment with the individual can bodies **29**. A crimping device **34** is actuated to crimp one of the can bases **33** into one end of each of the rectangular can bodies **29**. This crimping operation may be essentially similar to the corresponding operation performed on conventional tinplate cans, as described hereinafter in connection with FIGS. 14–17. Other methods of sealing the bases in the cans may be utilized, as set forth hereinafter in the description of FIGS. 18 through 29.

From base station **32**, each of the can bodies **29**, complete with a sealed-in base **33**, is moved onto a second conveyor **35**. At the transition point between conveyors **31** and **35**, an appropriate mechanism **36** may be utilized to invert each of the can bodies, so that the base **33** of each can body rests on conveyor **35** and the open end of the can body faces upwardly.

Continued movement of the partially closed can bodies along conveyor **35** brings each of the can bodies to a filling station **37**. At filling station **37**, the can body is filled, by appropriate metering and filling equipment represented in the drawing only by the outle conduit **38**, with the particular food, beverage, or other material to be stored in the can.

From filling station **37**, the filled can bodies proceed along conveyor **35** to a lid station **39**. At station **39**, strip of can lids **41**, which may be essentially similar to bases **33**, is fed into alignment with the can bodies on the conveyor. A crimping device **42** crimps or otherwise seals one of the can lids **41** onto each can, hermetically sealing the can and completing its construction. From station **41**, the filled and sealed cans continue their movement along conveyor **35** to a further packaging or storage location.

One important aspect of packaging system **10** is that it affords a practical and economical system for fabricating hermetically sealed cans from continuous seamless tubing. This is particularly advantageous as applied to the fabrication of aluminum cans, since seamless tubing suitable for use as the tubing **12** can be readily formed from aluminum by conventional extrusion apparatus. The use of a seamless tube as the initial and basic portion of the can body eliminates completely the equipment normally used to solder, weld or otherwise bond a flat strip of tin plate or other metal into a tubular form. Moreover, any problem of potential leakage at seams in the can body is eliminated.

The corrugation of the individual can lengths afforded

by embossing station **17** is also of substantial importance in connection with the present invention. To be economically practical, cans manufactured in accordance with the invention should be fabricated from stock which is of minimal thickness as compared to the stock used for ordinary cans. Indeed, it is desirable that the tube stock employed be as thin as possible in order to reduce the cost of the cans to a minimum, particularly where aluminum is utilized in constructing the cans. But aluminum is not as strong as steel of corresponding thickness, by a factor of approximately two to one, depending upon the alloys being compared and their hardness. Moreover, cans of rectangular or square cross-sectional configuration, such as the can bodies **29**, are somewhat weaker than cans of circular cross-sectional configuration. The corrugations afforded in the flattended strip **15** at embossing station **17**, however, which are retained in the completed can structure, add materially to the strength of the completed can. The corrugated construction utilized for the can bodies makes it possible to employ thin gauge material, comparable in cost to the material employed for conventional cans, without susbtantial loss of strength. Moreover, the corrugated constructions employed in the invention provide additional advantages with respect to high thermal conductivity and the reproduction of striking advertising messages, as discussed more fully hereinafter.

Shipment of the completed can blanks, in strip form, from the central can manufacturing location to the cannery, is quite economical as compared with the shipment of empty cans. Shipping costs are frequently computed on the basis of carload lots or on the basis of a unit termed as "measurement ton" which is really a measurement of volume rather than weight. Costs thus computed on a volume basis, as applied to empty cans, are quite high. Shipment of the can blanks in roll form, as on the drum **23**, affords a major reduction in shipping costs because the space requirements for shipment of a given number of cans are tremendously reduced.

From the foregoing description of the packaging system **10** of FIG. 1, it will be apparaent that the particular forms of apparatus illustrated therein are not essential to performance of the basic inventive method. FIG. 8 affords a flow chart of the method of the invention as carried out by packaging system **10** or by other comparable means. As shown in FIG. 8, the first step in the invention, step **11A**, is to procure a supply of thin-wall metal tubing. This tubing can be continuous seamless extruded tubing or may be fabricated by welding from a strip of flat stock. The wall thickness will depend to some extent upon the size of the cans to be fabricated, the material to be contained in the cans, and the metal or alloy used in fabrication of the cans. A wall thickness of four to six mils, for example, may be utilized for aluminum cans, using an alloy of moderate hardness, with the can having a capacity of twelve ounces and used for liquid storage.

The thin wall tubing is flattened, as indicated by step **13A** in the flow chart of FIG. 8. This is preferably done on a continuous basis by roller apapratus or by passing the tubing through a pair of converging platens or by other comparable means. Index notches are cut or otherwise formed in the flattened tubing to define individual can lengths. The flattened tubing is then imprinted, if desired, with an appropriate identification, advertising message, or the like, step **16A**.

After the tubing is flattened and imprinted, it is embossed from the exterior, and from both sides, as indicates by step **17A** in the flow chart. Again, roller embossing apparatus may be utilized to perform step **17A** but it is equally practical to utilize an intermittent press device with appropriate embossing platens or other apparatus for this purpose.

Following embossing step **17A**, the embossed flattened tubing is coiled on an appropriate reel or other coil form and is then ready to ship to the point of use as indicated by **23A** in the flow chart of FIG. 8. At the cannery or other plant where the cans are required, the flattened and embossed tubing is cut into individual can blanks as indicated by step **24A**. These individual blanks are then expanded to cylindrical form (step **28A**). The ultimate configuration of the expanded can blanks is dependent upon the type of can required by the user. As explained more fully hereinfater, a particular can blank can be expanded into a cylindrical can body of rectangular, circular, square or virtually any other desired cross-sectional configuration.

The next step in the process is to apply a base to each of the expanded can blanks, step **32A**. Any one of a number of different specific techniques may be employed to seal the base to the can body. Thus, the conventional crimping techniques used in the fabrication of ordinary tinplate cans are readily applicable to the can bodies constructed in accordance with the present invention. On the other hand, and particularly where aluminum is used as the material for the can bodies, more positive crimping methods and even cold pressure welding techniques may be employed, particularly where a high quality hermetic seal is essential. A number of different specific sealing techniques are described hereinafter.

Once the base is sealed into the can body, the can body is filled with the material to be stored in the can, step **37A**. Thereafter, it is only necessary to apply a lid to each can and to seal the lid into the can (step **39A**). The sealing technique used for the lids may be the same as for the sealing of the bases into the can bodies.

From the flow chart of FIG. 8, it will be apparent that step **23A** may be eliminated where cans are manufactured complete, filled, and sealed at a single location. But a substantially continuous, one-location process of this sort is most practical, economically, at large-volume canning plants and hence is less commonly employed.

It is not essential to the present invention that the flattened can blanks be shipped in continuous strip form as illustrated in FIG. 1 and as described above in connection with FIG. 8. Instead, the shearing station **24**, described in conjunction with FIG. 1 as being located at the cannery, may instead be located at the can manufacturing point. Under these circumstances, the individual can body blanks **27** are sheared from the continuous strip **15** at the central can manufacturing points as indicated by alternate stage **24B** in FIG. 8. The individual flattened, embossed can blanks are then shipped to the cannery or other point of use in stacks rather than rolled on a drum. Shipment of the can bodies in the form of pre-sheared stacked blanks (alternate step **23B**, FIG. 8) is just as economical as shipment in continuous strip form. The corrugated can blanks nest with each other and require a minimum of shipping space.

The equipment required at the cannery, starting with the expansion station **28**, FIG. 1, is generally similar to canning equipment required for conventional tinplate cans. The expanding station **28** is an addition to the normal cannery requirements but represents only a relatively small added increment of cost relative to the cost of conventional in-plant canning equipment. Much of the complete conventional cannery equipment has been omitted from FIG. 1, such as the apparatus required to prepare and process the material being packaged in the cans. The base application station **32** and the lid application station **39** may constitute equipment essentially similar to that used to apply the lids to conventional tinplate cans. The metering and filling equipment employed with cans constructed in accordance with the invention may be essentially identical with the corresponding filling apparatus employed for ordinary tinplate cans and other competitive packages.

Can structures—rectangular, vertically embossed

FIG. 3 illustrates a completed can constructed in ac-

cordance with the present invention. As shown therein, can body **29** retains the corrugations **19** formed in the can body blank at embossing station **18** (FIG. 1). At the lower end of can body **29**, the uncorrugated section **21A** affords a smooth transition section into which the base **33** is crimped to close and seal the bottom of the can. Similarly, at the top of the can the uncorrugated transition section **21B** affords a smooth joint with the lid **41** that is crimped or otherwise secured into the top of the can to complete the sealed package. The lid **41** of the completed container may be provided with a pull-up tab opener **42** of conventional construction to afford a convenient means for decanting the contents from the can. Tab openers such as opener **42** are presently in widespread commercial use in aluminum lids for otherwise conventional tinplate cans; accordingly, it is not necessary to afford a detailed description of the various forms of tab opener that can be employed.

FIG. 4 illustrates the substantial economy that may be realized with rectangular cans constructed in accordance with the form of the present invention illustrated in FIG. 3, insofar as storage space is concerned. As shown in FIG. 4, the individual can bodies **29** may be nested with each other to afford a compact group of cans. Six of the cans **29** are shown in nested relation in FIG. 4, but additional cans may be grouped together in any required number.

The phantom outline **44** in FIG. 4 illustrates the additional space that would be required for storage of six cans of conventional circular configuration having the same capacity as the rectangular cans **29**. As will be apparent from FIG. 4, and particularly with reference to the packages of six cans used commercially for the sale of beverages, the storage space requirements are materially reduced with the rectangular cans of the present invention. Moreover, the cost of paperboard cartons and packages for six-can units or other commercial grouped units is materially reduced.

FIG. 3A illustrates, on a reduced scale, the form and configuration of the lid **41** for the completed can illustrated in FIG. 3. Lid **41** is of the same construction as base **33**, except that the base has no opener tab **42**. On cans where no opener tab is provided, the lid and base are identical to each other. As shown in FIG. 3A, lid **41** is a simple rectangular cup-shaped member having side walls of flanges **46** of limited height. The side walls **46** are crimped together with the edges of the can body **29** or otherwise sealed thereto as described more fully hereinafter.

One unique advantage afforded by the corrugated can structures of the present invention, such as the can shown in FIG. 3, pertains to advertising or identification materials imprinted upon the can bodies at the preliminary stage of manufacture in the printing station **15** (FIG. 1). The desired lettering, pictures, and other advertising or identification material may be imprinted in sections, being divided between portions appearing on oppositely facing facets of the corrugated side walls such as the facets **47** and **48** in FIG. 3. Thus, by looking at the can from the angle shown in FIG. 3, one particular message imprinted upon the unshaded facets **47** may be made visible; by viewing the can from a different direction, in which the shaded facets **48** are exposed, a substantially different image, message, or color is revealed.

In order to make it possible to erect or expand the can body blanks into substantially symmetrical rectangular vertically corrugated can bodies, from pre-embossed flattened tubular stock, certain geometrical considerations should be adhered to. It can be demonstrated that expansion of a flattened pre-corrugated can body blank, having complementary longitudinal corrugations throughout a major portion of the surface area, into symmetrical rectangular form, can be achieved by regulation of the corrugation facets and of the number of pairs of corrugation facets. Specifically, the can body blank should be formed with an even number of corrugation facets and with an integral number of pairs of corrugation facets in order to permit expansion of the blank into a can body that is symmetrical in configuration about a given transverse longitudinal plane. Furthermore, if it is desired to provide a can body of square or rectangular cross-sectional configuration, then the corrugation of the can body blank should afford an odd integral number of pairs of corrugation facets.

FIG. 2 is a chart of corrugation configurations comprising eight columns **51**, **52**, **53**, **54**, **55**, **56**, **57** and **58**. Each column lists a total number of longitudinal corrugation facets that may be afforded in a can body blank. The first column **51** includes configurations providing an even number of corrugation facets and an odd integral number of pairs of corrugation facets. Can body blanks having the numbers of corrugation facets listed in column **51** may be expanded to afford symmetrical can bodies which are either square or of at least one other rectangular cross-sectional configuration, as described more fully hereinafter.

Columns **52**, **54**, **56** and **58** pertain to configurations in which there are an odd number of corrugation facets. A can body having an odd number of corrugation facets cannot be achieved by ordinary embossing or similar metal-forming procedures applied to a flattened tubular blank, since the odd number of facets requires differing treatment of the two opposed sides of the flattened tube. Consequently, it is not practical to construct can body blanks having the numbers of corrugation facets listed in columns **52**, **54**, **56** and **58** by embossing the flattened tubing.

If an even number of pairs of longitudinal corrugation facets are provided, it is not possible to expand the can blank into either a rectangular or square shape or any close simulation thereof without substantial deformation of one or more portions of the corrugations. The reason for this is that it requires three corrugation facets or panels encompassing the reverse bends at the two edges of the flattened corrugated tubing to provide for two of the four corners of the expanded can body, as is illustrated and described more fully hereinafter in connection with FIGS. 5 through 7. Thus, although it is readily possible to fabricate can body blanks having even numbers of pairs of corrugation facets as listed in columns **53** and **57** of FIG. 2, such blanks are not ordinarily usable for the manufacture of rectangular can bodies where the tubing is flattened completely with two direct reverse bends, as in the system described in FIG. 1, because the expanded can bodies would be irregular and unsightly in configuration.

Column **55**, however, does list additional combinations of facet members that may be employed in longitudinally corrugated cans constructed in accordance with the system illustrated in FIGS. 1 and 8. That is, a can body blank constructed with the number of corrugation facets listed in any portion of column **55** affords an even number of corrugation facets and an odd number of pairs of corrugation facets. These particular combinations, however, can only be erected to afford rectangular can bodies having sides of different lengths and cannot be expanded to afford square can bodies.

The smallest reasonably usable number of longitudinal corrugation facets listed in column **51** of FIG. 2 is eighteen. FIG. 5B illustrates a corresponding flattened corrugated can body blank, shown in cross-section, having eighteen corrugation facets. The individual corrugation facets are identified in FIG. 5B by letters A through R. The right-hand edge of the can body blank comprises a second reverse bend affording the corrugation facets I and J.

Expansion of the can body blank **61** into a substantially square can body is shown in FIG. 5A. As shown in FIG. 5A, expansion of the can body blank **61** results in the formation of one corner that includes the three individual corrugation facets I, J and K, facets I and J having initially formed the right-hand reverse bend of the flat-

tened blank, FIG. 5B. Similarly, the opposed corner of the expanded can body includes the three individual corrugation facets A, B and R from the reverse bend at the opposite edge of the blank. The remaining two corners of the expanded square can body each include two corrugation facets. Thus, one corner is afforded by the corrugation facets or panels E and F and another by the elements N and O, bent slightly from their initial corrugation angles but still extending in the same general directions relative to each other. It will be observed that the expanded can body is essentially symmetrical about a transverse plane indicated in FIG. 5A by the phantom line **62**.

The can body blank **61** could also be expanded into a rectangular form other than a square. This could be accomplished by forming one corner with the corrugation facets C and D and another with the opposed pair L and M. It will be recognized that the resulting can configuration would not be particularly attractive but this is due primarily to the fact that the can body blank **61** illustrated in FIGS. 5A and 5B includes only a minimum number of corrugation facets.

FIG. 6 illustrates a can body **63** erected from a corrugated blank having a total number of seventy-four corrugation facets and thus affording thirty-seven pairs of corrugation facets. Two of the corners **64** and **65** of the can body **63** each include three corrugation facets; these corners include the two reverse bends at the opposite edges of the original flattened and corrugated can body blank. The two remaining corners **66** and **67** each include only two corrugation facets. The right and left-hand sides **68** and **69** of the can body **63**, from corner to corner, each include a total of twenty-eight corrugation facets. The upper and lower sides **72** and **73** of the can body, as shown in FIG. 6, each include a total of thirty-six corrugation facets. Thus, it is seen that the can body **63** is of rectangular configuration having an aspect ratio of nine to seven. Can body **63** is symmetrical about a transverse plane indicated by the phantom line **74** extending through the corners **64** and **65**. It will be recognized that the rectangular cylindrical can body **63** is also symmetrical about the transverse plane taken through the corners **66** and **67**.

FIG. 7 illustrates a can body **83** expanded from a corrugated blank that is in all respects identical to the blank used to form the can **63** of FIG. 6. Again, the can body **83** has two corners **84** and **85** that are each formed by three individual corrugation facets, these being the corners of the can body formed from the reverse bend edge portions of the corrugated blank. The remaining corners **86** and **87** each include only two corrugation facets and are formed from the central portion of the corrugated blank. In this instance, each of the four sides **88**, **89**, **92** and **93** includes thirty-two corrugation facets, so that the aspect ratio of the can body **83** is unity and the can body is essentially square in cross-sectional configuration. The can body **83** is symmetrical with respect to a transverse plane, indicated by the phantom line **94**, through corners **84** and **85**. Indeed, the can body **83** is essentially symmetrical about any transverse plane taken through the geometrical center of the can body.

As pointed out above, can bodies such as the members **63** and **83** illustrated in FIGS. 6 and 7 cannot be constructed with an odd number of longitudinal corrugation facets, where the corrugations are of equal size and extend throughout the surface of the can, and cannot be practically formed by embossing a flattened tube from the exterior sides thereof. If the corrugations total an even number of pairs of corrugation facets, then it is not possible to utilize three individual facets for the reverse-bend corners, such as the corners **84** and **85** in FIG. 7, and at the same time maintain an equal number of corrugation facets on the sides of the container. Moreover, if an even number of pairs of corrugation facets are employed, it is necessary to flatten or even to reverse one of the embossed corrugations when the can blank is expanded to form a can body. This necessitates metal forming equipment of substantial size at the location at which the can blanks are expanded and effectively dissipates many of the advantages of the present invention.

FIGS. 9 through 13 afford detailed views of the embossed strip of can blanks issuing from the embossing station **17** of the system **10**, FIG. 1. As clearly illustrated in FIG. 9, adjacent can blanks **101**, **102** and **103** are separated by an intervening unembossed section **21** of the flattened corrugated tube **15**. Preferably, indexing notches **104** and **105** are formed in the edges of the unembossed portion **21** of the tubing between adjacent can body blanks such as blanks **101** and **102**, before imprinting of the flattened blanks. A similar pair of indexing notches **106** and **107** identify the point of separation between the adjacent blanks **102** and **103**. These indexing notches afford a convenient means for assuring precise indexing of the printing on the can blanks and accurate severing of the individual can blanks from each other with uniform lengths, thereby assuring the fabrication of cans of uniform capacity.

As indicated by the detail views, FIGS. 10 through 13, embossing of the corrugations **19** is preferably symmetrical with respect to the flattened tubing. The flattening of the tubing is maintained substantially uniform throughout the width of the tubing to avoid deformation of the completed cans. The depth of the corrugations **19** is of course dependent upon the width of the flattened tubing **15** and the number of corrugations required in the completed can. In the illustrated construction, the corrugations **19** are of uniform depth, and this construction is preferred because it affords a more uniform outward appearance for the container and because there is less likely to be difficulty in stacking the flattened containers for shipment. However, variations in the depths of the corrugations for special visual effects can be effected without substantial sacrifice of the benefits of the invention. Care should be exercised to avoid flattening the edges of the tube too sharply, to avoid creating a weakened line longitudinally of each can. As shown in FIGS. 12 and 13, some relief may be permitted along the edges.

Sealing of cans

The base and lid of each can may be effectively sealed into the can body by conventional crimping techniques employed in the manufacture of tinplate cans, by cold pressure welding, particularly when using aluminum, or by other practical and effective means for sealing a relatively flat lid into an open-ended can body. FIGS. 14 through 17 illustrate one practical procedure, a technique that is similar to the crimping procedures used in the manufacture of conventional cans.

As shown in FIG. 14, when lid **41** is to be sealed into expanded can body **29**, the lid is placed within the upper opening of the can body, in the uncorrugated portion **21B**. A separate mechanism may be provided for holding lid **41** suspended in the illustrated position in FIG. 15, or the lid may be supported by the internal projecting portions of the corrugations **19**. Preferably, lid **41** is held in place by a slight draft to the flanges **46**. It should be noted that the uncorrugated transition portion **21B** of can body **29** terminates below the upper edge **111** of lid **41**.

Sealing of can lid **41** into can body **29** is accomplished simply by bending the upwardly extending flange **46** of can lid **41** over the edge of the can body transition section **21B** and crimping the two together. This crimping operation is illustrated at intermediate stages in FIGS. 15 and 16 and is shown in its completed form in FIG. 17. The flange **46** of lid **41** and the uncorrugated portion **21B** of the can body afford a continuous sealed bead around the edge of the can and provide adequate hermetic sealing for most applications. If desired, sealing compound can be used, coating the sealing flanges **46** and **21B**, and will accumulate in the areas **112** and **113** (FIG. 17) to further reduce the possibility of an inadequate seal.

FIGS. 18 through 21 illustrate another effective and economical procedure for sealing bases and lids into cans and like containers constructed in accordance with the present invention. The technique illustrated in these figures is particularly applicable to aluminum cans. As shown in FIG. 18, a suitable lid **141** may first be supported in the open end **21B** of an expanded can body **29**. In this instance, the lid or base **141** is provided with an outwardly diverging sealing flange **146** so that, when placed in the open end **21B** of the can body, the lid rests in the illustrated position. From the position shown in FIG. 18, the lid is forced inwardly of the sealing section **21B** of the can body, gripping the interior wall of the can body in the position illustrated in FIG. 19.

With lid **141** in position, narrow continuous peripheral strips of the lid flange **146** and the can body sealing flange **21B** are simultaneously forced together under high pressure, along the entire can rim and from opposite sides, as indicated by the indentations **147** and **148** in FIG. 20. Indentations **147** and **148** may be formed by appropriate rollers or by other convenient means, depending upon the configuration of the can body and the associated lid. In this instance, the reduction in cross-section of the metal is quite high, ranging from sixty to ninety percent, so that a continuous cold pressure weld is formed in the region **149** intermediate the two indentations. To facilitate this weld, the adjoining edges of the lid and can body surfaces are appropriately cleaned or otherwise treated prior to cold pressure welding. Conventional mechanical cleaning, as by scratch-brushing with a wire brush can be used; another treatment that may be employed is that described in Patent No. 3,139,678 of Myron L. Anthony and Robert F. Gill, entailing controlled oxidation of the weld surfaces.

By this above-described cold welding technique, a complete hermetic seal is formed at the periphery of the can and the lid. The sealed can could be left in the condition illustrated in FIG. 20. However, there is always some possibility that the rim portion above the indentations **147** and **148** could be broken off, particularly since the metal remaining at the seal is quite thin, which might result in a breaking of the seal for the container. Consequently, it is preferred to crimp the upper sealed portion of the can rim inwardly as shown in FIG. 21 to complete the mounting of lid **141** in the can and to protect the seal.

A further sealing technique suitable for cans constructed in accordance with the present invention is illustrated in FIGS. 22 through 25. In this instance, a can lid (or base) **151** is first mounted in the smooth transition or sealing flange portion **21B** of the can body **29**. Lid **151** may initially be supported in position by a slight draft to the sealing flange **156** of the lid, in the manner illustrated in FIG. 18, or by other suitable means. The lid is then forced inwardly of the can to the position shown in FIG. 22, with the upper rim **157** of the lid well below the upper rim **158** of the can body.

The next step is completing the seal illustrated in FIGS. 22–25 is to indent the initial surface of the lid flange **156** just above the surface of the lid, as illustrated in FIG. 23, forming an inner peripheral indentation **159** in the lid flange. This indentation **159** need not provide for sufficient reduction in thickness of the metal to afford a cold pressure weld seal. Nevertheless, a reasonably good seal is provided at this stage of fabrication. Although only one indentation **159** is shown in FIG. 23, it should be understood that two or more indentations may be afforded if desired to increase the quality of the seal and to afford a better mechanical bond between lid **151** and the can flange **21B**.

After indentation **159** is formed, the upwardly projecting portion or rim **158** of can sealing section **21B** is bent over and crimped as shown in FIG. 24. If desired, an appropriate sealing compound can be employed to fill in the open space left by crimp **159** above the upper rim **157** of lid **151**. This affords a strong hermetically sealed joint between lid **151** and can sealing flange **21B** and completes the can structure.

Where maximum mechanical strength for the joint between lid **151** and can flange **21B** is required, it may be desirable to indent the inwardly crimped portion of flange **21B** as shown in FIG. 25. That is, a further indentation **160** may be formed in the inwardly bent portion of flange **21B**, preferably in alignment with the peripheral indentation **159** in lid **151**. This provides a further mechanical interlock between the can body and the lid and gives even more positive assurance that the lid and body will remain hermetically sealed to each other until such time as it may be desired to open the can.

FIGS. 26 through 29 illustrate another method that may be employed to seal lids and bases into the cans. Initially, an appropriate can lid (or base) **161** is inserted into the open end or sealing flange **21B** of the can body **29**. The side flanges **166** of lid **161** may be initially formed with a slight draft to support the lid on the open ennd of the can to begin with, similar to the arrangement illustrated in FIG. 18. The sealing operation begins by forcing lid **161** into the upper open end **21B** of the can body so that the flange **21B** on the can body and the flange **166** on lid **161** are approximately parallel to each other as shown in FIG. 26. It should be noted that in this instance the flange **166** of lid **161** projects well above the upper edge **158** of the can body.

The next operation is to indent flange **21B** from its external surface, as shown in FIG. 27. At least one complete peripheral indentation is formed, more than one indentation may be utilized as indicated by the indentations **164** and **165** in FIG. 27. The one indentation **164** is located immediately above the upper surface of lid **161**. As in the sealing arrangement described above in connection with FIGS. 22–25, the reduction in thickness of metal at the indentations **164** and **165** need not be sufficient to form a cold pressure weld between the lid and the can body.

The next step in this operation is to bend the upper portion of the flange **166** over the upper edge or rim **158** of the can body and to crimp the same over the rim of the can body as shown in FIG. 28. Again, an appropriate sealing compound may be utilized to fill in the indentations **164** and **165** and the open space **167** above rim **158**. This arrangement provides an external flange surrounding the can lid that is particularly useful where conventional can openers are to be utilized in opening the can. Again, to provide a stronger mechanical joint, the external surface of flange **166** may be indented as indicated by reference numerals **168** and **169**, in alignment with the indentations **164** and **165** respectively. However, the latter step is not always essential and a relatively strong hermetically sealed construction in afforded even if fabricaation tion is considered complete at the stage illustrated in FIG. 28.

In the sealing procedures illustrated in FIGS. 22–25 and 25–29, because the lowermost indentations are made near the flat face of the lid and because of the internal geometry of the lid and can structure, any tendency for the lid to move inwardly to unlock the mechanical indentation seal is effectively minimized. Expansion of the outer wall of the can could unlock the seal, but this is prevented by crimping the projecting flange over the indented flange as shown in each of these sealing arrangements. The roll crimp afforded in each instance prevents unlocking expansion of the outer wall and at the same time provides a safety edge that prevents failure by peeling at the indented joint between the lid and the can body.

As above noted, for the seal embodiments of FIGS. 22 through 29, the thickness reduction ratio is relatively small compared to the indentations used in cold pressure welding, being only about thirty percent of the combined stock thickness, compared to indentations as high as eighty or ninety percent for pressure welding. Plastic coatings or other surface contamination, as by the material contained in the can, does not interfere with the mechanical inter-

lock seals provided by these methods. The combination of interlocking indentations and flange crimps affords strong, tightly sealed containers.

In cans provided with plastic coatings, the constructions illustrated in FIGS. 22 through 29 can be further modified to improve the quality of the hermetic seal. Thus, the lid and base flanges, or the can flange, or both, may be coated with a plastic material that polymerizes under pressure; plastic materials of this kind are now well known in the art. In mounting the lids in the cans as described above, the application of high pressure in the indented areas causes the plastic material to polymerize or "cure," affording extra strength to the joint as well as providing further assurance against any possibility of leakage at the seal.

Can structure modifications

The container illustrated in FIG. 3 is of rectangular configuration and is vertically embossed throughout virtually its entire surface area, the only uncorrugated portion of the surface being the two transition sections 21A and 21B at the ends of the can which provide a convenient and effective means for sealing a lid and a base into the can. A construction of this kind is strong and compact, yet may be inexpensively manufactured, particularly in accordance with the system described in connection with FIGS. 1 and 8. On the other hand, a number of modifications and variations may be made, with respect to the can configuration and the alignment and distribution of the strengthening corrugations, without departing from the present invention and, indeed, retaining most of the advantages of the initially described embodiment. Moreover, some of the modifications afford special advantages of their own.

FIG. 30 illustrates a container **201** constructed in accordance with another embodiment of the present invention; FIG. 31 is a plan view of an embossed strip of can blanks utilized in manufacturing can **201**. Referring to FIG. 30, it is seen that container **201** is of rectangular configuration, the drawing showing two side walls **202** and **203** of the can together with the can lid **204**. The base of the can may be essentially identical with lid **204**. The remaining side walls of the can are identical in construction to walls **202** and **203**.

Container **201** is not provided with vertical corrugations as in the previously described embodiment. Rather, container **201** is embossed, in manufacture, to afford a multiplicity of horizontally extending corrugations in the side walls thereof. On the front wall **203**, there are two sets of horizontal corrugations, an upper group **205** and a lower group **206**. The horizontal corrugations in both groups **205** and **206** extend virtually the full width of the can, leaving only narrow uncorrugated strips **207** and **208** at the corners. The smooth, uncorrugated strip **208** extends around the corner from the front wall **203** to the side wall **202** of container **201**, wall **202** being provided with two groups of horizontal corrugations **211** and **212** aligned with groups **205** and **206** respectively on the front wall. The horizontal corrugations **211** and **212** extend for virtually the entire width of the side wall, leaving only the narrow strip **208** at one side and a similar narrow uncorrugated strip **213** at the opposite side of the corrugations.

On the front wall **203** of can **201**, the upper and lower group of corrugations **205** and **206** are separated by a relatively narrow uncorrugated area **214**. Area **214** may be utilized for mounting of an adhesively secured identification label or for imprinting the can with data identifying the can contents. As noted above, in connection with the embodiment of FIG. 3, the corrugated portion of can **201** may be imprinted with advertising and basic identification material. The label or other identification applied to the can in the unembossed medial portion **214** thereof makes it possible to affix specific identification data to a can structure used for a general line of related products. By way of example, if cans such as can **201** are utilized for the packaging of soup, the advertising and identification data imprinted or otherwise applied to corrugated sections **205** and **206** may be of general nature identifying the manufacturer and indicating that the product contained within the can is soup. A small adhesive label or small imprint applied to uncorrugated section **214** may then be utilized to identify the particular variety of soup within the individual can, distinguishing it from other kinds of soup sold under the same general brand.

With respect to can **201**, certain important considerations should be observed. In the first place, a major portion of the total can surface is embossed to afford a multiplicity of corrugations, as clearly illustrated in the drawing. It is not sufficient to afford a few widely spaced corrugations or rings in the can structure. To achieve the strength necessary for adequate protection of the can contents while utilizing thin-gauge materials, most of the can surface should be embossed to afford the desired strengthening corrugations. In the can illustrated in FIG. 30, the corrugations cover about sixty-five to seventy percent of the total can surface. They should be utilized throughout at least sixty percent of the can surface. This results in a can structure that is "fully embossed," in accordance with the present inventive concept, affording the requisite strength to the completed can structure despite the use of thin-gauge material in forming the can walls. In this specification, and in the appended claims, the term "fully embossed" is defined as requiring embossing of sixty percent or more of the surface area of the can body.

In other respects, can **201** is essentially similar to the can described hereinabove in connection with FIG. 3. Thus, narrow upper and lower portions **214** and **215** of the can body are left uncorrugated to provide a smooth transition for sealing the lid and the base to the can. The sealing techniques employed for this can structure may be the same as described hereinabove in connection with FIGS. 18 through 29. Can lid **204** may be provided with a suitable opener tab if desired.

FIG. 31 illustrates an embossed strip **217** of flattened can body blanks utilized in the manufacture of cans such as the can **201** of FIG. 30. The can blank strip **217** is formed from tubular stock, flattened and subsequently embossed, in flattened form, in the manner described hereinabove in connection with FIG. 1. As shown in FIG. 31, two narrow strips **207** and **213** are left free of embossures at the edges of the flattened strip of can blanks **217**; when the can blanks are expanded as described in connection with FIG. 1, and discussed in greater detail hereinafter, strips **207** and **213** (FIG. 31) form two corners of the can body (FIG. 30). The intermediate unembossed strip **208** makes it possible to form an intermediate corner in the can body without breaching the metal, as might occur if the horizontal embossures were carried across the entire width of the strip.

FIG. 32 illustrates a container **221** that is generally similar to can **201** of FIG. 30 but is embossed in accordance with a somewhat different pattern. In container **221**, which is of rectangular configuration, the front wall **223** is provided with upper and lower embossed areas **225** and **226** separated by an intermediate unembossed section **238** that may be utilized for applying a specific identification label or imprint to the can. In this instance, however, neither horizontal embossure nor vertical embossure are employed. Instead, each of the upper and lower embossed areas **225** and **226** are embossed in a linear intersecting pattern, the lines of embossure extending normal to each other and at angles of 45° to the horizontal and vertical sides of the can. This results in a diamond-shape pattern of embossure which affords a strong structure resistant to bending and to casual indentation in virtually any direction. This configuration for the embossure affords excellent strength characteristics. It does not permit convenient use of variant messages imprinted upon differently aligned faces of a linear embossure pattern, as described above in connection with the can of FIG. 3 and as could be utilized also on the horizontally embossed can of

FIG. 30. However, attractive general identification can be imprinted upon the wall areas **225** and **226**, making due allowance for some distortion as a result of embossure of the can walls.

The side wall **222** of can **221** is also provided with upper and lower embossed sectors **231** and **232**. As in the can of FIG. 30, narrow corner portions **227**, **228** and **229** are left free of embossure so that the can can be expanded to rectangular form without breaching the can wall. Moreover, and as in the previously described embodiments, narrow upper and lower edges **234** and **235** are left unembossed to provide for a smooth transition section at each end of the can body into which the lid and base of the can may be hermetically sealed. Again, any of the sealing techniques described hereinabove can be utilized in completing the can structure.

FIG. 33 illustrates a strip **237** of flattened tubular can blanks, embossed after flattening, that may be utilized in constructing can **221** of FIG. 32. As most clearly shown in FIG. 33, the can body blanks are fully embossed, the corrugations extending throughout the major portion of the surface areas of each can blank. The total area of the embossed sectors **225**, **226**, **231** and **232** should be at least equal to one-half the total area of an individual can blank and preferably substantially more than one-half.

FIG. 34 illustrates another embodiment of a container constructed in accordance with the present invention. The metal can **241** shown in FIG. 34 is quite similar to can **221** of FIG. 32 in that it includes a plurality of upper and lower sectors **245**, **246**, **251** and **252** of diamond-shaped embossures. In this instance, however, the can is not expanded to rectangular configuration; rather, a cylindricail configuration of circular cross-section is employed. In can **241**, in addition, the medial portion **247** of the can, between the upper and lower embossed areas, is embossed to afford a rib **248** girdling the can. Rib **248** may be interrupted at two points corresponding to the edges of the flattened embossed strip of can blanks if the can body for container **241** is fabricated in accordance with the method of FIGS. 1 and 8. Using this technique, one semi-circular segment of rib **248** projects outwardly of the can and a second semi-circular segment projects inwardly of the can. On the other hand, if the alternative fabricating system described hereinafter in connection with FIG. 41 is utilized, a continuous rib **248** can be formed around the entire periphery of the can, projecting either inwardly or outwardly of the can as desired.

On container **247**, the vertical unembossed portion **249** of the can wall between embossed sectors **245** and **251** may be employed to apply an identifying label or imprint to the can. Any of the other narrow unembossed portions of the can separating the embossed segments thereof may be utilized for a similar purpose. On the other hand, it should be recognized that the upper portion of the can need not be completely consistent with the lower portion; for example, the embossed areas **246** and **252** of the can may be merged to eliminate entirely the unembossed sector **253** in the form shown in FIG. 34. Furthermore, if desired, additional circular ribs such as the embossed rib **248** may be incorporated in the can structure.

The lid and base of container **241** may be essentially similar in construction to the lid and base elements described above except that they are of circular configuration rather than being rectangular. Alternatively, elliptical or other cross-sectional configurations can be utilized for the cylindrical can bodies and their mating bases and lids if preferred. Again, lids and bases may be sealed to the can bodies by any of the techniques described hereinabove. An appropriate tab opener may be incorporated in the can lid if desired.

FIG. 35 illustrates another circular can or container **261** that is somewhat similar to can **251** of FIG. 34. In this instance, the upper portion **262** of the can body wall is provided with a multiplicity of vertical embossed corrugations. The corrugated sector **262** extends around the complete periphery of the can. The lower portion **264** of the can is similarly provided with sets of vertically extending embossed indentations or corrugations.

The central peripheral portion **265** of can **261** is free of the vertical embossures employed in the upper and lower sectors **262** and **264**. This part of the can, however, is embossed to afford a strengthening rib or corrugation **266** that extends around approximately one-half of the can. A similar corrugation or rib **267** girdles the remaining half of the can periphery at the central portion of the can. The short unembossed sector **268** separating the two rib sections **266** and **267** corresponds to the edge of the flattened tubular can strip, when embossed in accordance with the system of FIGS. 1 and 8, and, consequently, affords a connecting vertical rib **269** between the upper and lower embossed sections. Using the other system embodiment described hereinafter in connection with FIG. 41, a complete continuous rib can be provided to replace the interrupted rib structure **266**, **267**; the short connecting vertical corrugation **269** being omitted. As before, suitable base and lid members may be sealed into can **261** in accordance with any of the techniques described hereinabove. Moreover, can **261** may be formed in an elliptical or other cross-sectional configuration as desired.

FIG. 36 illustrates yet another container **271** of circular cross-sectional configuration. Can **271** is embossed with a series of vertically extending corrugations **272** that extend essentially the full height of the can. In this regard, it should be noted that the can **271** can be formed directly from the blank or can body **29** illustrated in FIGS. 9–13. That is, the can blank for the circular can may be the same as the can blank for a rectangular or square can. If deemed essential to a particular application, a minor portion **273** of the can surface may be left smooth and free of corrugations **272** for the application of a specific identification label or imprint. In all other respects, can **271** is essentially similar to those described above. Note that can **271** has two ribs or corrugations with three facets, like corner corrugations **64** and **65** (FIG. 6) formed by expansion of the edges of the flattened tubular blank.

In each of the can structures of the present invention, as noted above, it is important that a major portion of the can surface be embossed to afford strengthening rib structures so that thin gauge material may be used in the fabrication of the can bodies. It is equally important that the embossure be of sufficient depth to afford ribs projecting inwardly and outwardly of the median line of the can wall, on each side thereof, for a distance at least equal to the thickness of the metal employed in the wall and preferably for a distance substantially greater than the wall thickness. Stated differently, shallow embossures that merely change the wall appearance and do not afford actual rib structures are not adequate to the present invention. In this connection, reference may be made to FIGS. 12 and 13 which illustrated approximate minimum depths for the embossing of the corrugations relative to the wall thickness. Moreover, the corrugations should be formed by stretching the metal, not merely bending it, to increase the total wall area and work-harden the metal.

In addition to strengthening the can walls, fully embossed corrugated walls tend to increase thermal conductivity of the containers. This is a material advantage in packaging some goods, such as frozen foods and any foods and beverages that are ordinarily chilled before serving. Moreover, the working of the metal walls entailed in the embossing process is effective to work-harden the metal, particularly with aluminum but also with other metals, further strengthening the container walls.

Can expansion apparatus

FIGS. 37 through 39 illustrate apparatus that may be employed to expand the individual can body blanks **27** produced at the shearing station **24** into the required configuration for the can bodies **29**. That is, the apparatus shown in FIGS. 37 through 39 represents one form of

equipment that may be employed at the expanding station **28** of the system **10** (FIG. 1). A modified form is illustrated in FIG. 40.

The can expansion apparatus **340** illustrated in FIG. 37 comprises a feeder apparatus **341** that is located at the left-hand side of the figure. Feeder apparatus **341** is employed to feed a series of the individual can blanks **27** from a stack **343** into the expansion apparatus. Feeder device **341** may comprise a plurality of guide members **344** mounted on a base **345**, together with suitable means for supporting the stack **343** of can body blanks within the guide members. An appropriate mechanism is provided for progressively raising the stack **343** to maintain the topmost blank on the stack at the desired level for feeding into expansion apparatus **340**. This mechanism may be essentially similar to the corresponding mechanisms used in a variety of sheet-feeding applications; inasmuch as such devices are well known, no specific form of stack-lifting mechanism has been illustrated.

The blank-feeder apparatus **341** is also provided with a vacuum feeder member **346** that moves reciprocably from left to right in FIG. 37 to feed the topmost blank **27** from the stack **343** toward the right as seen in the drawing. Again, feeder apparatus of this nature is well known and the feeder element **346** has been shown only schematically. The initial movement of the upper blank **27** from the stack, in the direction of the arrow **347**, is continued by a plurality of feed rolls **348**.

Expansion apparatus **340** further includes a pair of travelling vacuum expansion members **351** and **352**. The travelling expansion member **351** is mounted upon a pair of guide members **353** and **354**. Similarly, expansion member **352** is supported upon a pair of longitudinal guide members **355** and **356**. As shown in FIG. 38, the central portion of expansion member **351** includes a tubular extension **357** that projects downwardly from the expansion member and terminates in a vacuum gripping element **358**. Suitable means are provided for moving vacuum gripper **358** in a vertical direction for a purpose described hereinafter. The construction of expansion member **352** is similar to member **351**; it includes a forwardly projecting tubular member **359** that terminates in a vacuum gripper **360**.

Expansion members **351** and **352** are aligned with a pair of expansion jaws **361** and **362**. Power means (not shown) are provided for moving jaws **361** and **362** toward and away from each other.

At the outset of a can blank expansion operation, the two vacuum expansion members **351** and **352** are moved to the left from the position shown in FIG. 37 and into alignment with a can blank **27A** that has been fed from the top of the stack **343**. The two vacuum gripper elements **358** and **360** are thus brought into aligned engagement with the can blank, gripping the blank firmly. The vacuum connections for the grippers are generally illustrated by the hoses **363** and **364**.

Once a firm grip has been established between each of gripper elements **358** and **360** and can blank **27A**, expansion members **351** and **352** are moved to the right to bring can blank **27A** into expansion jaws **361** and **362** as shown in FIG. 38. Movement of the expansion members **351** and **352** is guided and controlled by guide members **353**, **356** so that can blank **27A** is accurately aligned in the two jaws **361** and **362**. It should be noted that each of jaws **361** and **362** is provided with a pair of internal surfaces that are angularly oriented with respect to the flat can blank **27A**.

With can blank **27A** in the position shown in FIG. 38, the two jaws **361** and **362** are moved toward each other, pushing against the edges of the corrugated can blank. At the same time, vacuum grippers **358** and **360** are pulled away from each other to expand the central portion of the can blank. In this manner, the initial opening of the can blank is achieved, expanding the can blank toward the position shown in FIG. 39.

Ultimately, the two vacuum grippers **358** and **360** reach the limit of their vacuum hold on the can blank and are released from engagement with the can blank. Alternatively, the vacuum supply to the grippers can be shut off to release the grippers after the can blank has been partially expanded. Expansion devices **351** and **352** are then moved back toward their starting or feeding position to begin the next cycle of operation.

With the vacuum grippers out of the jaws, the inward movement of the jaws **361** ond **362** is continued, forcing the can blank into conformation with the interior jaw faces to provide a completed expanded can body of the desired configuration. To assist in this expansion, the end faces of the jaws may be sealed off by suitable closure plates and compressed air may be forced into the interior of the can blank, from a suitable source, as indicated by the compressed air outlet **166** in FIG. 37.

It may also be desirable to afford a more positive can blank expansion action within the expander jaws. To this end, a pair of internal expander members may be inserted within the partially expanded can blank, during the final closing movements of the jaws to force the can blank outwardly into full conformity with the expander jaws. FIG. 40 illustrates an expansion arrangement of this kind, embodying two expander jaws **361A** and **362A**, the jaws being shown in the same relative position as jaws **361**, **362** in FIG. 39. A pair of internal expander members **371** and **372** are inserted within the partially expanded can blank **27B** in the jaws **361A**, **362A**. As jaws **361A**, **362A** continue to close, members **371**, **372** move outwardly to assure full expansion of the can body.

Packaging system II

FIG. 41 comprises a flow chart illustrating another form of the present invention that is closely related to the method described hereinabove in connection with the flow chart of FIG. 8 but that is modified somewhat with respect thereto. The initial step **311** of the packaging method shown in the flow chart of FIG. 41 is the same as the first step in the first-described method; a supply of thin-wall metal tubing is first procured. This tubing may be welded or extruded tubing or may be fabricated in any other suitable metal affording adequate strength characteristics. The metal may be aluminum and, indeed, this is usually preferred, but other types of metal tubing may be utilized in carrying out the method of the invention.

The thin-walled metal tubing is flattened as indicated by step **313** in FIG. 41 and is then imprinted with advertising, identification, or other pertinent data (step **316**).

Thereafter, the flattened imprinted tubing may be coiled and shipped to the cannery, brewery, or other plant at which the tubing is to be used for fabricating hermetically sealed cans or like containers, as indicated by step **323** in the process chart of FIG. 41. At the point of use, step **324**, individual can blanks are cut from the flattened imprinted tubing. These can blanks are expanded, step **328**, and only then are embossed to afford the strengthening corrugations required in accordance with the present invention, step **317**. It is thus seen that the embossing step **17A** that was performed early in the method of FIG. 8 is performed at a substantially later time as step **317** in the modified method of FIG. 41.

The remaining steps in the initial method illustrated in the flow chart of FIG. 41 are the same as for the previously described embodiments. That is, the embossed expanded can bodies are first provided with suitable bases, the bases being sealed into the can bodies in accordance with any of the several techniques described above. After application of the bases, step **332** in FIG. 41, the cans are filled (step **337**). Finally, appropriate lids are applied to the can bodies and sealed thereinto, in step **339**, to complete the hermetically sealed containers.

A further modification of the inventive method, also illustrated in FIG. 41, provides for severing of the individual can blanks from the flattened metal tubing at the point of initial manufacture. Thus, and as indicated

by step 324A in FIG. 41, the individual can blanks may be cut from the continuous flattened tubing at the point of can manufacture, preferably after the desired advertising, identification, and other legends have been imprinted upon the can stock. This makes it possible to ship flattened individual can blanks to the point of use as shown by step 323A. Following this technique, the can blanks can be expanded and embossed, preferably in a single operation, at the point of use, as shown by stage 328A in the flow chart of FIG. 41.

Can embossing apparatus

FIGS. 42, 43 and 44 illustrate one method and means by which individual can blanks can be fully expanded to their final cylindrical form and also embossed to afford a fully embossed can structure according to the present invention. As shown in FIGS. 42 and 43, the combination expansion and embossing apparatus comprises a pair of external die members **251** and **252** which mate with each other and afford a completely enclosed die. The interior surface of die member **251** is formed with a series of teeth **253** and a corresponding plurality of teeth **254** are formed on the inner surface of die member **252**. The teeth **253** and **254** in die members **251** and **252** define the corrugations to be formed in a can blank processed in the expansion and embossure apparatus **250**.

Apparatus **250** further includes a tapered expansion cone **255** that extends upwardly through the central opening in the two die members **251** and **252** and that is concentrically aligned with the external die members. A plurality of individual expansion and embossure members **256** are disposed within die members **251** and **252** around the periphery of the expansion cone **255**. Members **256**, referred to hereinafter as the punch members of the embossing apparatus, are individually aligned with the depressions **257** and **258** between the teeth **253** and **254** in the inner surfaces of the die members **251** and **252**. That is, for each slot or groove **257** around the interior surface of die member **251**, there is a punch member **256**, and the same relation applies to the notches or grooves **258** in the die member **252**.

In placing the expansion and embossing apparatus **250** in use, a smooth, partially expanded uncorrugated can blank **261** is located within the two die members **251** and **252**. The can blank is disposed between the two die members and the individual punch members **256** as shown in both FIGS. 42 and 43. With the apparatus thus aligned, the expansion cone **255** is driven upwardly in the direction of the arrow **263** (FIG. 43) to drive punch members **256** radially outwardly into the notches or grooves **257** and **258** in the external die members.

Continued advancing movement of the expansion cone into apparatus **250** causes the punch members **256** to force the thin-wall can blank **261** outwardly into the grooves in the encompassing die members. The final position of the apparatus is shown in the detail view of FIG. 44, in which it is seen that the punch members force the metal of the can wall into each of the notches **257**, completing expansion of the can body and simultaneously embossing the same with a plurality of relatively deep corrugations to complete a can body conforming to the requirements of the present invention.

In connection with the combined expansion and embossure apparatus **250** of FIGS. 42–44, it should be noted that, where integrated manufacture is desired and the complete cans are manufactured at point of use, it is not necessary to start with a flattened tubular can. Instead, the starting material may be individual lengths of thin-wall metal tubing in their original cylindrical configuration, whether of circular, rectangular, or other desired cross-section. Thus, can bodies fully corresponding to the present invention may be fabricated without preliminary flattening where there is no necessity for shipping the can bodies from one location to another.

On the other hand, and particularly in those instances where it is essential to ship the can bodies any substantial distance, the expansion and embossing apparatus **250** may be utilized with pre-flattened can bodies so long as the can bodies are partially expanded prior to the final expansion and embossing operation carried out in this device. It may also be noted that the can bodies need not be initially fabricated from a continuous length of tubing but can be manufactured on an individual basis by a drawing or extrusion operation of a small quantity of metal; a preferred manufactuing technique of this kind is described and claimed in the co-pending application of Myron L. Anthony, Ser. No. 610,377, filed Jan. 19, 1967.

In the expansion and embossing apparatus **250**, the die member grooves **257** and **258** and the individual punch members **256** do not extend the full height of can body **261**. Rather, the punches and the mating die cavities terminate short of the full length of the can body so that the completed can body retains a smooth transition rim at each end into which appropriate base and lid members may be sealed.

Although apparatus **250** is shown in a form suitable for fabricating a can of circular cross-section, appropriate modifications may be made in the apparatus for expanding and embossing rectangular, elliptical, and other can shapes. Moreover, apparatus **250** is not limited to formation of multiple vertical corrugations in the completed can bodies but can be employed for horizontal corrugation patterns, as described above, as well. Small areas can be left smooth and uncorrugated, by appropriate modification of the embossing and expansion apparatus **250** for application of specific identification labels or imprints. Other forms of expansion apparatus, such as resilient pressure-expandable members, dual expander cones, or the like, may be utilized as desired.

FIG. 45 illustrates another form of embossing apparatus that may be utilized with can bodies already expanded to their desired configuration, pursuant to that form of the system described hereinabove in connection with FIG. 41. The embossing apparatus **270** illustrated in FIG. 45 is particularly useful as applied to cans of circular cross-sectional configuration.

The embossing apparatus **270** of FIG. 45 is quite simple; it comprises, essentially, a pair of embossing gears **271** and **272**. The external embossing gear **271** has a multiplicity of embossing teeth **273** projecting downwardly of its periphery. The internal embossing gear **272** affords a corresponding multiplicity of radially projecting embossing teeth **274** that mesh with the teeth **273** of embossing gear **271**. The two embossing gears are preferably of the same size and configuration, and are arranged so that the teeth on each gear interfit into the spaces between teeth on the other gear. It will be recognized that the teeth **274** on the internal embossing gear **274** need not be uniform and need not all extend for the full axial height of the gear provided any interruptions or variations in the embossing teeth are aligned with complemental variations in the pattern of teeth on the external embossing gear **271**.

For an embossing operation, gears **271** and **272** are displaced from each other a short distance and a can body **275** is positioned between the two gears. The two gears are then brought together and are rotated relative to each other to emboss the can body with a multiplicity of corrugations **276**. Of course, the pattern of teeth on the two gears **271** and **272** should provide the desired corrugations such as corrugations **276** throughout more than one-half of the surface area of can body **275**, producing a can body that is fully embossed in accordance with the present invention. Moreover, if there are any variations in the size, spacing, or other features of the embossing teeth, these factors should be correlated with the circumference of the can body to avoid multiple overlapping embossure of the can body.

In all of the several embossing techniques described hereinabove, an additional advantage is derived, over and above the strength imparted to the can bodies by the formation of the ribs or corrugations therein. The stretch-

ing and working of the metal that takes place in the embossing operation is effective to at least partially work-harden the metal, so that the can body is materially strengthened over and above the additional strength imparted by formation of the corrugations themselves. Thus, to at least a limited extent, the metal itself is made stronger by the embossing operation in addition to being given a stronger structural configuration.

In any of the embossing procedures, and as noted above, it is not sufficient merely to press a pattern into the surface of the metal; fully defined ribs or corrugations are necessary to provide the strong containers characteristic of the present invention. The overall depth of the corrugations should, at a minimum, be at least three times the thickness of the metal. That is, for metal walls of given thickness D, the metal should be bent outwardly of the center line of the can body by an amount at least equal to the same thickness D and should also be bent inwardly of the can body by the same amount, producing corrugations having a total effective height of three times D. Moreover, it is usually desirable to provide corrugations of substantially greater depth than this minimal limitation. In typical small containers used for the storage of beverages, foods, and the like, it is usually desirable to provide corrugations or ribs having an overall height of $\frac{1}{64}$ to $\frac{1}{10}$ inch.

Internal coating of can stock

In those instances in which the material to be stored may be adversely affected by contact with the metal from which the containers are fabricated, it may be desirable to apply a plastic coating or other coating to the interior of each can. If the coating is applied after the individual cans have been completed in construction, or even after the can bodies have been expanded to their final form, the coating process becomes an expensive procedure that is difficult to control. FIGS. 46 and 47 illustrate a convenient and inexpensive method and apparatus for applying a continuous internal coating to the tubing from which the can bodies are fabricated prior to processing.

As shown in FIG. 46, a continuous strip of thin metal stock **301** is fed over a roller **302** and between a series of pairs of deflecting rollers **303** and **304**. Only two pairs of deflecting rollers **303** and **304** are illustrated, but it should be understood that additional pairs of said rollers can be utilized so that the deflecting rollers bend the opposed edges of the sheet metal strip **301** into a closed tubular configuration as indicated at reference numeral **305**. After being thus bent to tubular form, the generally tubular sheet metal **305** continues its feeding movement in the direction of the arrow **306** into an automatic welder apparatus **307** which welds a seam joining the adjacent edges of the sheet metal tube. After welding, the tube **308** is fed into a re-drawing apparatus, much like an extruder, that re-draws the tube to afford a smooth seamless configuration.

Apparatus for forming seamless welded tubular stock from a strip of sheet metal, as thus far described in connection with FIG. 46, is essentially conventional. Accordingly, there is no need to describe in detail the welding apparatus **307** or the re-drawing apparatus **309**. In this instance, however, and as shown in FIG. 46, a feeder tube **310** extends from a point adjacent the flat strip stock **301** ahead of the deflecting rollers **303** and **304** and into welder **307** or, indeed, completely through the welder into the re-drawing apparatus **309**. Tube **310** terminates in a spray head **312** within the welded tube **308** as shown in FIG. 47. An appropriate coating solution is introduced into conduit **310**, under pressure, as indicated in FIG. 46, and sprays out into the interior of the tube **308** as shown in FIG. 47. The rate of delivery of material from the spray head **312** is correlated with the speed of movement of tube **308** so that a uniform and complete plastic or similar coating **314** is built up on the interior of the tube. Coatings of this kind can be made flexible enough to maintain their integrity through the embossing operations and other operations entailed in completing the cans as described above, so that the end product is a completed can having an inert coating throughout its interior surface.

Conventional resin coatings can be applied, using the apparatus of FIGS. 46 and 47 to good advantage; on the other hand, and particularly where cold pressure welding is to be utilized in sealing the can lids or bases into the cans, it is preferable to modify the plastic coatings to afford improved sealing characteristics. To this end, convention resin or lacquer coatings are modified by the inclusion of substantial quantities of finely divided inert abrasive materials. Typical abrasive materials that may be utilized include alumina, garnet, and carbide materials. These typical materials are highly refractory, hard, and generally chemically inert and insoluble. Garnet in particular is quite inexpensive and is in mass production for use in sandpaper and similar articles.

The abrasive material is reduced to a finely divided form, as by ball mill, and is mixed with the conventional plastic coating material in the same manner as pigments are added thereto. When the coating is applied to the can, the abrasive material is substantially completely embedded in the plastic or at least completely coated by the plastic material. Sharp-fracturing abrasive materials should be used, in the largest possible grain size. Thus, the abrasive material should be of the order of 600 to 1000 mesh size.

Ordinary unmodified plastic coatings tend to lubricate the surfaces of the metal can body and metal lid, permitting those surfaces to slide relative to each other when pressure is applied in the course of the sealing operation. This lubrication action retards and in many instances prevents cold pressure welding of the can body and lid (or base). Incorporation of the abrasive material in the coating causes effective interlocking of the surfaces as the plastic is squeezed out under pressure and increases the tendency for the surfaces to gall. This has been demonstrated to enhance the cold pressure weldability of the surfaces.

In all of the illustration of can structures provided in the drawings, the strengthening corrugations in the cans are shown as having relatively flat sides and sharply defined corners. This construction affords maximum strength longitudinally of the corrugations and makes it possible to construct cans from thin-wall aluminum tubing or other flexible metal tubing that will have adequate dent and pressure resistance to withstand normal usage. Rounded or sinusoidal corrugations are not as desirable because they do not give adequate strength in a longitudinal direction. In the ensuing claims, it should be understood that the term "corrugation" refers to constructions having relatively straight walls and sharp corners. Of course, this is not applicable to pressure bands such as the encompassing bands **248** and **266** (FIGS. 34 and 35) which may be generally U-shaped in cross-sectional configuration.

It is also important to note that widely spaced separate embossures or other indentures, although covering a wide area over all, will not produce the strong lightweight cans afforded by the present invention. The corrugations employed should be closely packed with respect to each other and should be continuous and contiguous, as shown in the several drawings, so that a major part of each can wall consists of corrugation facets extending at a substantial angle to the centerline of the wall. This construction affords a marked increase in the sectional modulus of the can wall, an increase of the order of 30:1 in many instances. Occasionally spaced striations in the can will not accomplish the objectives of the invention.

Hence, while preferred embodiments of the invention have been described and illustrated, it is to be understood that they are capable of variation and modification.

I claim:

1. A substantially completely flattened tubular can

body blank terminating at its longitudinal edges in two reverse bends, said can body blank being fully embossed from opposite sides to afford an even total number of flat-faced corrugation facets therein, adjacent corrugation facets joining each other in a sharp-angled bend, the longitudinal ends of said can body blank being free of corrugations to afford smooth transition sections adaptable to smooth, continuous sealing of closure members into a can body formed by expansion of said blank to cylindrical form.

2. A flattened tubular can body blank according to claim 1 and having identification data imprinted on said corrugation facets in registry therewith to display messages of variant form depending upon the angle from which the blank is viewed.

3. A substantially completely flattened, tubular, longitudinally corrugated can body blank terminating at its longitudinal edges in two relatively flat reverse bends, said can body blank having an even number of flat-faced corrugation facets and an odd integral number of pairs of corrugation facets to permit expansion of said can body blank into a can body of rectangular cylindrical configuration that is symmetrical about a transverse longitudinal plane.

4. A completely flattened, tubular, longitudinally corrugated can body blank terminating as its longitudinal edges in two flattened reverse bends, said can body blank having an even number of flat-faced corrugation facets and an odd integral number of pairs of corrugation facets to permit expansion of said can body blank into a can body of rectangular cylindrical configuration that is symmetrical about a transverse longitudinal plane, said can blank having identification data on said corrugations and in registry therewith to display messages of variant form depending upon the angle from which the blank is viewed.

5. A substantially completely flattened tubular can body blank terminating at its longitudinal edges in two relatively flat reverse bends, said can body blank being fully embossed from opposite sides along a series of parallel, longitudinal lines to afford an even number of flat-faced corrugation facets and an odd integral number of pairs of corrugation facets therein to permit expansion of said can into a can body of rectangular cylindrical configuration symmetrical about a transverse longitudinal plane, the longitudinal ends of said can body blank being free of corrugations to afford smooth transition sections adaptable to hermetic sealing of closure members into a can body formed by expansion of said blank to cylindrical form.

6. A seamless, flattened tubular aluminum can body blank terminating at its longitudinal edges in two reverse bends, said can body blank having a longitudinally continously longitudinal flat-faced corrugated central portion including an even number of corrugation facets and an odd integral number of pairs of corrugation facets to permit expansion of said can body into a can body of cylindrical configuration that is symetrical about a transverse longitudinal plane;

said can body blank further having uncorrugated end portions extending longitudinally beyond the corrugated central portion to provide for smooth continuous seals with end closure members for the expanded can body,

and said can blank having continuous identification data overlapping a plurality of said corrugations and in registry therewith to present different information to a viewer when viewed from differing angles.

7. A rectangular cylindrical can body, symmetrical about a given transverse longitudinal plane, formed of thin-wall metal tubing, and fully embossed to afford a multiplicity of longitudinally extending flat-faced corrugations extending over a major portion of the surface area of said can body, the depth of said corrugations exceeding three times the wall thickness of said can body, said corrugations completely girdling said can body, two opposed corners of said can body each including three corrugation facets and the two remaining opposed corners of said can body including only two corrugation facets.

8. A rectangular can body according to claim 7 and having identification data imprinted on said corrugation facets in registry therewith to display messages of variant form depending upon the angle from which the can is viewed.

9. A cylindrical can body, symmetrical about a given transverse longitudinal plane, formed of thin-wall metal tubing, and fully embossed to afford a multiplicity of longitudinally extending flat-faced corrugations extending over a major portion of the surface area of said can body, the depth of said corrugations exceeding three times the wall thickness of said can body, said corrugations completely girdling said can body, two diametrically opposed longitudinal corrugations on said can body each including three corrugation facets and the remaining intermediate corrugations on said can body each including only two corrugation facets.

10. A round cylindrical can body, symmetrical about a given transverse longitudinal plane, formed of thin-wall aluminum and expanded from a flattened tubular blank fully embossed, while flattened, to afford a multiplicity of longitudinally extending flat-faced corrugations extending over a major portion of the surface area of said can body, the depth of said corrugations exceeding three times the wall thickness of said can body, said corrugations completely girdling said can body, two diametrically opposed longitudinal corrugations on said can body each including three corrugation facets and the intermediate corrugations on said can body including only two corrugation facets.

11. A thin-wall metal can comprising

a cylindrical can body fully embossed to afford multiplicity of flat-faced corrugations extending inwardly and outwardly of the can body wall, the depth of said corrugations exceeding three times the thickness of the can body wall;

said can body having smooth, uncorrugated transition sections at the opposite ends thereof;

a pair of closure members, each sealed into a respective end of said can body, each closure member including a peripheral sealing flange extending substantially parallel to the can body wall in surface-to-surface contact with a respective one of said transition sections;

said closure member sealing flange and said can body transition section being hermetically sealed and mechanically bonded by cold-pressure welding one to the other along a continuous line encircling said can body;

and at least one of the mating surfaces, at the cold-pressure weld between said sealing flange and said transition section, having a resin coating containing substantial quantities of large-mesh-sharp-fracturing inert abrasive material, the galling action effected by said abrasive material during formation of the cold-pressure weld enhancing the quality of the finished weld.

12. A thin-wall aluminum can comprising:

a cylindrical can body having smooth sealing sections at the opposite ends thereof;

a pair of aluminum closure members, each sealed into a respective end of said can body, each closure member including a peripheral sealing flange extending substantially parallel to the can body wall in a respective one of said sealing sections;

said closure member sealing flange and said can body end section being hermetically sealed and mechanically bonded by a cold-pressure weld therebetween along a continuous line around said can body;

and a resin coating on the interior surface of said can body, containing substantial quantities of large-mesh sharp-fracturing inert abrasive material, the galling

action effected by said abrasive material during formation of the cold-pressure weld enhancing the quality of the finished weld.

13. A substantially completely flattened tubular can body blank terminating at its longitudinal edges in two reverse bends, said can body blank being fully embossed from opposite sides to afford a multiplicity of flat-faced corrugation facets therein, adjacent corrugation facets joining each other in sharp-angled bends, with a first group of said corrugations extending approximately normal to a second group thereof in intersecting relation, the longitudinal ends of said can body blank being free of corrugations to afford smooth transition sections adaptable to smooth, continuous sealing of closure members into a can body formed by expansion of said blank to cylindrical form.

References Cited

UNITED STATES PATENTS

994,995	6/1911	Gray	220—72 X
850,167	4/1907	Lee	220—72
3,315,839	4/1967	Catalano et al.	220—72
28,014	4/1860	Scaife	220—72
137,590	4/1873	Bard	220—67
563,962	7/1896	Hinde	229—90
758,908	5/1904	Gair	229—90
861,242	7/1907	Edison	220—72
898,944	9/1908	Weber	220—67
1,387,640	8/1921	Brainard	113—121
1,557,826	10/1925	Geiger	113—121
1,565,809	12/1925	McCrery et al.	220—67
2,005,641	6/1935	Stanitz et al.	220—72
2,063,013	12/1936	Cooper	220—72
2,327,731	8/1943	McClary	220—67
2,522,408	9/1950	Sowter	29—470.1
2,894,323	7/1959	Sowter	29—470.1
2,941,064	6/1960	Gieser et al.	220—67
3,115,987	12/1963	Barnstead	220—67
3,207,358	9/1965	Fliss	220—64
3,226,820	1/1966	Anthony et al.	29—470.1
3,268,109	8/1966	Coppens	220—72

FOREIGN PATENTS

100,113	1/1937	Australia.
1,203,964	8/1959	France.

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