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ROLLED SHEETS HAVING OPENINGS THERETHROUGH
AND PROCESS FOR THEIR MANUFACTURE
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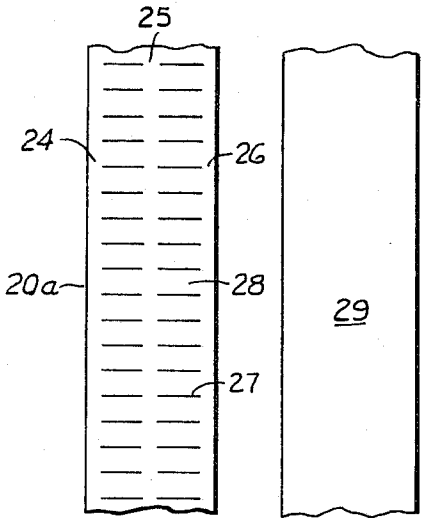


Fig. 5 Fig. 7

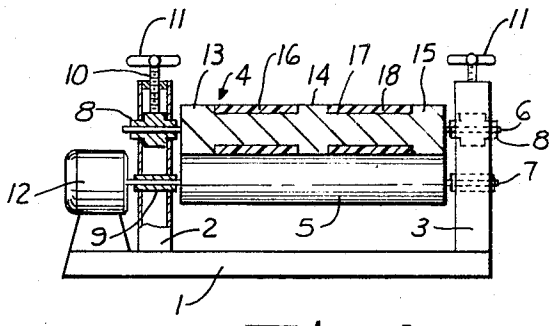


Fig. 1

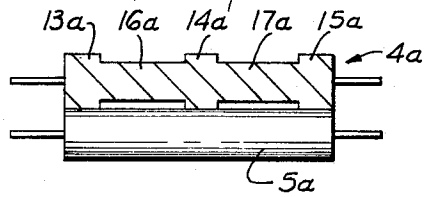


Fig. 2

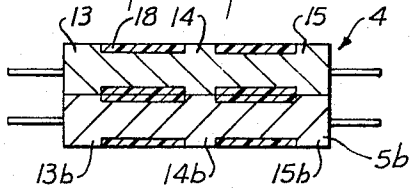


Fig. 3

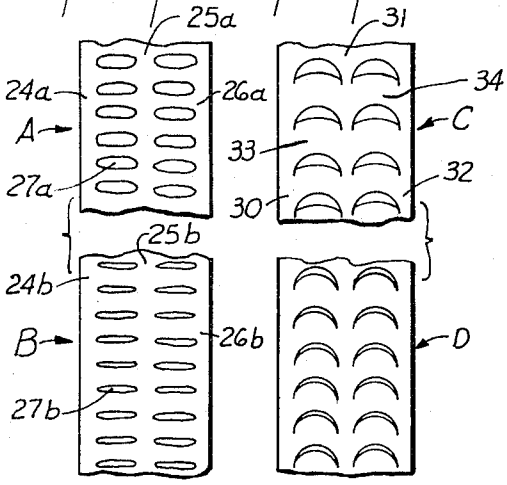


Fig. 6 Fig. 8

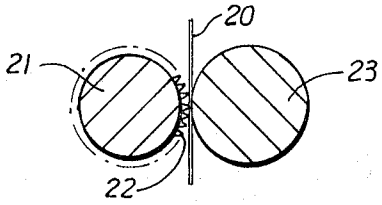


Fig. 4

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ROLLED SHEETS HAVING OPENINGS THERETHROUGH AND PROCESS FOR THEIR MANUFACTURE

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6 Claims. (Cl. 29—6.1)

This invention relates to the art of forming openings through sheets of malleable material, such as malleable metals or malleable plastics. It includes a process for forming openings through such sheets and a product which has particular utility as parts of racks for receiving elongate objects, or for sides of ventilated boxes or cabinets, but is not limited to such use.

Expanded metal has long been made by slitting a sheet of metal with the slits in staggered relationship to each other and applying tension to the slit sheet to expand the slits into diamond shape. This process is an excellent one when diamond-shaped openings have total area equivalent to a major part of the area of the expanded sheet are desired; but when openings of other shapes, such as oval or crescent shape, are desired, and especially when the total area of the openings is to form only a minor part of the total area of the expanded sheet, this method is not satisfactory as sufficient tension on the sheet to expand the openings may tear the sheet.

It is an object of this invention to provide a process for forming a series of openings through a sheet of malleable material which is effective to form openings of oval, substantially rectangular or crescent shape.

Another object is to provide a process in which openings through the sheet of malleable material are shaped by application of rolling stress to the sheet.

Another object is to provide a process in which openings are torn in a malleable sheet during a rolling step and expanded to selected width.

Another object is to provide a process for shaping a series of openings in a sheet of malleable material by expanding the openings to selected width and size by application of rolling stress.

Another object is to provide a rolled sheet of malleable material having at least one series of openings therethrough in which the openings are of substantially equal size and shape and are substantially equidistant from each other in series.

Other objects, advantages and features of this invention will be apparent to one skilled in the art upon a consideration of the written specification, the attached claims and the annexed drawings.

The process of the present invention includes a rolling step in which a substantial differential in rolling stress is applied to adjacent areas of the sheet. Comparatively heavy rolling stress, sufficient to elongate the sheet substantially, is applied to at least two continuous, laterally spaced, longitudinal areas of the sheet limiting a central area between them. Not more than sufficient rolling stress to cause substantially less elongation of the sheet is applied simultaneously to the central area. Elongation of the heavily stressed areas is sufficiently greater than that of the central area that the central area of the sheet is stretched substantially.

A series of transverse slits may be cut in the central area of the sheet prior to or during the rolling step, if desired, or the unslit sheet may be rolled. When the sheet is slit, stretching the central area by elongation of the laterally spaced, heavily stressed areas during the rolling step widens the slits to form openings of oval to substantially rectangular shape. When the sheet is unslit,

elongation of the heavily stressed, laterally spaced areas results in stretching and tearing the sheet in a series of locations in the central area. Further stretching the central area of the sheet widens the transversely torn openings into crescent shape.

The final shape of the openings through the sheet is controlled by a selected differential in rolling stress applied to the heavily stressed, laterally spaced areas and the central area between them. Maximum differential in rolling stress and maximum width of the openings are obtained when no rolling stress is applied to the central area, and the width of the openings becomes correspondingly narrower as the degree of stress applied to the central area increases. It will readily be seen that, if rolling stress sufficient to elongate the sheet in the central area be applied thereto, the stretching of the central area due to elongation of the heavily stressed areas will be decreased; and as the stretching effect is decreased, the openings will be widened to a lesser degree. Increase in rolling stress applied to the central area also results in wider spacing of torn openings in the central area due to a lesser differential in elongation between the central area and the heavily stressed areas.

The present process thus results in the formation of series of openings of desired shape in a sheet of malleable material by a simple rolling process. The degree of rolling stress is controlled to form openings of a desired size and shape. Control of rolling stress preferably is carried out by use of a machine having rolls which are adjustable toward and away from each other and constructed to apply greater rolling stress to the laterally spaced, longitudinal areas than to the central area between them.

No specific differentials in rolling stress can be stated since this differential will vary according to the characteristics of the particular malleable material being rolled and to the shape of openings desired in a sheet of this material. The degree of stress to be applied will be known approximately to those skilled in the art of rolling metal, and preferably the rolls are set at a distance to each other to give approximately the elongation required. The sheet of metal is then introduced between the rolls and pressure is adjusted to give openings of the desired shape. Each different batch of sheet material rolled may require a somewhat different adjustment, and the pressure is controlled throughout the rolling step to give openings of desired shape.

The machine of the present invention is a very simple one. It includes at least one pair of power-driven opposed rolls. At least one roll of the pair has laterally spaced shoulders thereon opposed to a cylindrical surface on the other roll. Each pair of shoulders defines a groove between them which extends circumferentially around the corresponding roll. This arrangement enables the application of heavy rolling stress to a sheet of material at locations where the sheet passes between the shoulders and the opposite roll while the circumferential grooves provide a differential in rolling stress applied to a central area between the shoulders and rolling stress exerted by the shoulders. The depth of the groove or, stated conversely, the height of the shoulders, is selected to give a selected differential in rolling stress applied to the laterally spaced areas of a sheet passing between the shoulders and the opposite roll and to the central area of the sheet passing between the groove and the opposite roll. This differential may result from application of no rolling stress at all in the area between the groove and the opposite roll, up to a degree of rolling stress sufficient to elongate the sheet substantially in this area, but with less elongation than in those areas of the sheet passing between the shoul-

ders and the opposite roll. Alternatively, the groove may be filled or partially filled with an elastic, compressible material of hardness selected to apply a selected degree of rolling stress to the central area of the sheet.

Means for driving the pair of rolls is provided, and a means for moving at least one of the rolls toward and away from the opposite roll is included.

The invention may be best understood on reference to the following detailed description and the attached drawings wherein like reference characters are used throughout to designate like parts and:

FIG. 1 is an elevation, partially in section, of one preferred device for applying a differential in rolling stress to adjacent areas of a sheet;

FIG. 2 illustrates a modification of the rolls of the device of FIG. 1;

FIG. 3 illustrates another modification of the rolls;

FIG. 4 illustrates one arrangement of slitting roll and backing roll adapted to slit a sheet of malleable material passed between the rolls transversely;

FIG. 5 illustrates a sheet of malleable material having transverse slits adapted to be expanded by application of differential rolling stress to adjacent longitudinal areas of the sheet;

FIG. 6 illustrates two sheets similar to the sheet shown in FIG. 5 after application of a differential in rolling stress to adjacent longitudinal areas of the sheet;

FIG. 7 illustrates an unslit sheet which may be treated by the process of this invention; and

FIG. 8 shows two sheets having crescent openings torn transversely therein and expanded to various widths by selected differentials in rolling stress applied to sheets similar to those shown in FIG. 7.

The device of FIG. 1 comprises a base **1** and supporting members **2** and **3** mounted thereon. A pair of cylindrical, opposed rolls, designated generally as **4** and **5**, are mounted upon axles **6** and **7** carried in bearings **8** and **9** disposed in supporting members **2** and **3**. The bearings **9** are illustrated as in fixed positions in supporting members **2** and **3**.

Shaft **6** is journaled in bearings **8** which are movable toward and away from bearings **9** so shaft **6**, bearings **8**, screw **10** and wheel **11** cooperate to form a means for moving roll **4** toward and away from roll **5** and thus to adjust pressure on a sheet of malleable material passing between rolls **4** and **5**. A means for driving the pair of rolls, illustrated as motor **12** attached to shaft **7**, is provided.

The roll **4** includes shoulders **13**, **14** and **15** which have cylindrical surfaces opposed to a cylindrical surface of roll **5**. Shoulders **13** and **14** define a groove **16** between them while a second groove **17** is defined between shoulders **14** and **15**. Grooves **16** and **17** are filled with an elastic compressible material **18**.

The modified pair of rolls shown in FIGS. 2 and 3 may be substituted for rolls **4** and **5** if desired. Roll **4***a* of FIG. 2 differs from roll **4** of FIG. 1 only in the omission of the elastic compressible material **18** from grooves **16***a* and **17***a*, respectively, defined by shoulders **13***a* and **14***a* and shoulders **14***a* and **15***a*. Rolls of the type shown in FIG. 2 are preferred when maximum differential in rolling stress is to be applied.

The rolls shown in FIG. 3 are each identical to roll **4** of FIG. 1 and are arranged so shoulders **13**, **14** and **15** run upon corresponding shoulders **13***b*, **14***b* and **15***b* of roll **5***b*. Each of the circumferential grooves around the corresponding roll defined between shoulders **13** and **14** and between shoulders **14** and **15** and between the corresponding shoulders on roll **5***b* are illustrated as filled with the compressible elastic material **18** although it is to be understood the elastomer may be omitted from one or both rolls if desired.

In operation when it is desired to produce a sheet having a series of openings of oval to substantially rectangular shape, a sheet **20** of malleable material may be passed between a slitting roll **21** equipped with a series of knives **22** adapted to slit the sheet, and a backing roll **23** as shown in cross section in FIG. 4. The resulting slit sheet will then have the appearance illustrated as **20***a* in FIG. 5. Alternatively, the roll **4***a* may be equipped with slitting knives longitudinally disposed in slits **16***a* and **17***a* and the slitting may be performed during the rolling operation.

The slitting operation results in initially parting the sheet transversely in a series of locations in longitudinal central areas limited by unslit areas of the sheet. The sheet **20***a* shown in FIG. 5 is in reduced scale and is of such width that unslit longitudinal areas of the strips **24**, **25** and **26** substantially correspond in width to the width of shoulders **13**, **14** and **15** on roll **4**, while the length of slits **27** does not exceed the width of grooves **16** and **17**. The sheet is started between the pair of rolls **4** and **5**, and pressure between the rolls is adjusted by adjustment of wheels **11** and screws **10** moving the pair of bearings **8** carrying shaft **6** and roll **4** toward or away from roll **5** to secure the desired degree of elongation of the longitudinal areas **24**, **25** and **26** of the sheet.

The differential in rolling stress applied to the longitudinal slit area on sheet **20***a* and the longitudinal areas **24**, **25** and **26** will result in elongation of the slit area by stretching and in opening the slits. When substantially no rolling stress is applied to the transversely slit area **28**, as will be the case when a roll such as **4***a* of FIG. 2 is used, the slits will be expanded to maximum width as illustrated in FIG. 6A. When a greater degree of rolling stress is applied to area **28**, as by use of rolls arranged as shown in FIG. 1, the slits will be opened to a lesser degree as shown at B in FIG. 6 to have the final configuration shown at **27***b*. In order to obtain the narrower configuration, the slit area has sufficient stress applied that there is some elongation of area **28** but not so much as in the rolled areas **24***b*, **25***b* and **26***b* of FIG. 6.

The degree of rolling stress to be applied is pre-selected by selecting a material **18** of hardness suitable for the sheet to be rolled. The hardness of elastic compressible materials on the market is well known as is the degree of malleability of various materials to be rolled. Thus, the operator may select from available materials suitable compressible materials to fill the slots **16** and **17**.

When a plain sheet, such as that designated as **29** in FIG. 7, is to be rolled, rolls arranged as shown in FIG. 2 result in tearing the strip transversely in central areas **33** and **34** located between adjoining longitudinal, heavily stressed areas **30**, **31** and **32**. The strip is torn transversely when no rolling stress or very light rolling stress is applied to areas **33** and **34**, and the resulting openings have crescent shape and maximum breadth as indicated in a rolled strip designated generally as C in FIG. 8.

Application of increased rolling stress to areas **33** and **34** results in the formation of crescent-shaped openings which are torn in the central areas by the expansion of areas **30**, **31** and **32**, but the resulting crescent openings are narrower than those which are formed when substantially no rolling stress is applied. The spacing of openings under these conditions also is somewhat wider than when little rolling stress is applied since the differential in elongation between the central area and the heavily stressed areas is smaller. It will thus be seen that the shape and longitudinal spacing of openings in a rolled strip may be controlled by controlling the degree of rolling stress applied.

In this specification and claims, the term "sheet of malleable material" is used to include materials of various weights, such as those commercially sold under the designation of "strip," "sheet" and "light plate" materials. The maximum weight or thickness of a sheet to be handled by this process will depend upon the malleability of the material and not upon the commercial designation.

From the foregoing it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and which are inherent to the process and apparatus.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

The invention having been described, what is claimed is:

1. In a process of manufacturing a sheet of malleable material having a series of openings therethrough, the step of applying rolling stress to laterally spaced apart longitudinal areas of the sheet which is sufficiently greater than that simultaneously applied to an unslit longitudinal area therebetween that the elongation of the laterally spaced apart areas relative to the unslit area will stretch said unslit area to cause it to tear at longitudinally spaced apart locations therealong.

2. In a process of the character defined in claim 1, wherein a relatively light rolling stress is applied to said unslit area.

3. In a process of the character defined in claim 1, wherein no rolling stress is applied to said unslit area.

4. In a process of manufacturing a sheet of malleable material having a series of openings therethrough, the steps of advancing the sheet having an unslit longitudinal area between a pair of rollers having at least one pair of laterally spaced apart shoulders for applying rolling stress to laterally spaced apart longitudinal areas of said sheet on opposite sides of the unslit area and adjusting the rollers relative to one another in order to apply rolling stress to the laterally spaced apart areas of the sheet which is sufficiently greater than that applied to the unslit area as to tear said unslit area at longitudinally spaced apart locations therealong.

5. A machine for forming openings in a sheet of malleable material, comprising a pair of opposed rollers, means for supporting the pair of rollers in substantially parallel position, one of said rollers having a pair of laterally spaced apart shoulders opposed to the other roller so as to provide a circumferential groove around the roller between the shoulders, said groove being substantially filled with an elastic compressible material, and means for adjusting the rollers toward and away from each other into cooperative position to apply selected rolling stresses to longitudinal areas of the sheet as it is advanced between the rollers.

6. A machine of the character defined in claim 5, wherein the other roller also has laterally spaced apart shoulders thereon opposed to the shoulders of the first-mentioned roller to provide a circumferential groove therebetween opposed to the groove on said first-mentioned roller, said groove in the other roller also being substantially filled with an elastic compressible material.

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RICHARD H. EANES, JR., *Primary Examiner.*