United States Patent

Wells

[15] **3,700,368**

[45] **Oct. 24, 1972**

[54] **CONTINUOUS MOLDING APPARATUS**

[72] Inventor: **Howard E. Wells,** 218 Shadmore Drive, Rochester, N.Y. 14626

[22] Filed: **Jan. 22, 1969**

[21] Appl. No.: **814,868**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 460,404, June 1, 1965, abandoned.

[52] **U.S. Cl.** **425/115,** 425/4, 425/817, 425/363

[51] **Int. Cl.** **B29c 3/02,** B29g 7/02

[58] **Field of Search** ..18/4 B, 4 M, 15 M, 15 S, 14 M, 18/5 P, 35, DIG. 44, 12 TB

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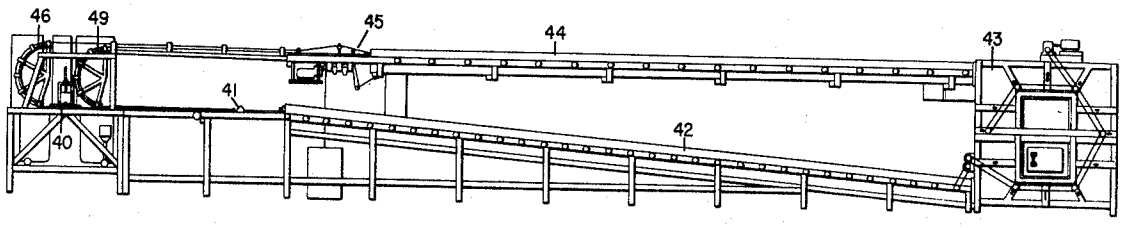
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Primary Examiner—Robert L. Spicer, Jr.
Attorney—Cumpston, Shaw & Stephens

[57] **ABSTRACT**

A continuous foamed strip molding method and apparatus uses two continuous lengths of mold halves that snap-fit together to hold the foamed strip and are flexible enough to be driven in a curved path with one mole half inside the other for high speed and adequate cure time in relatively small space.

20 Claims, 25 Drawing Figures



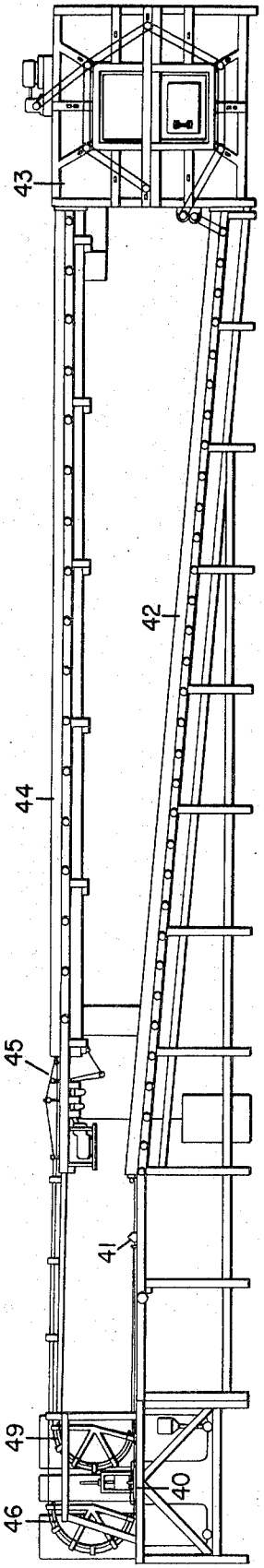


FIG. 1

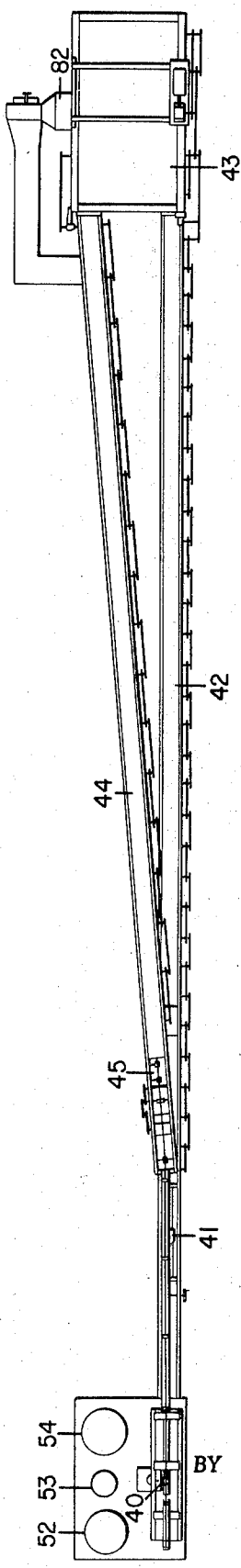


FIG. 2

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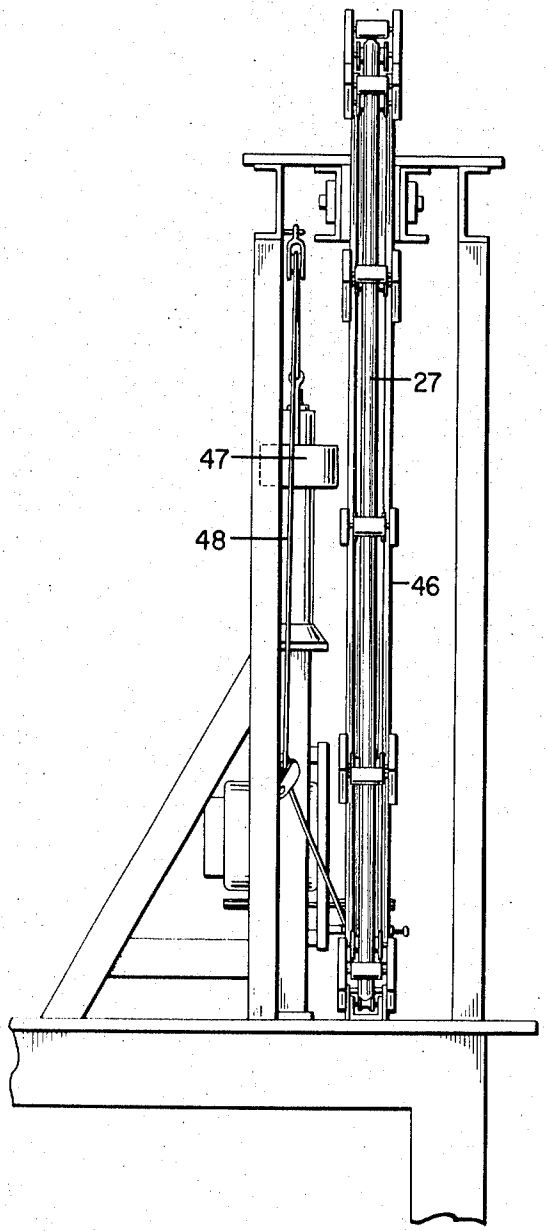


FIG. 3

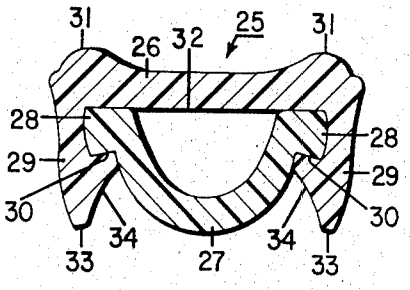


FIG. 4

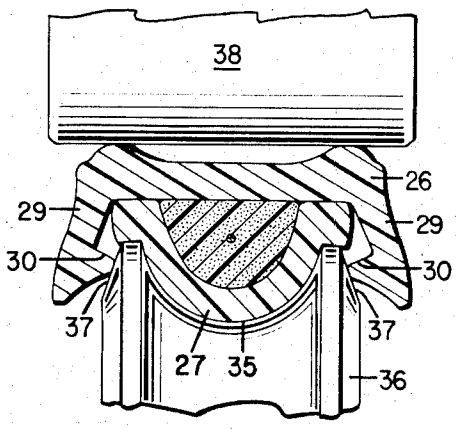


FIG. 5

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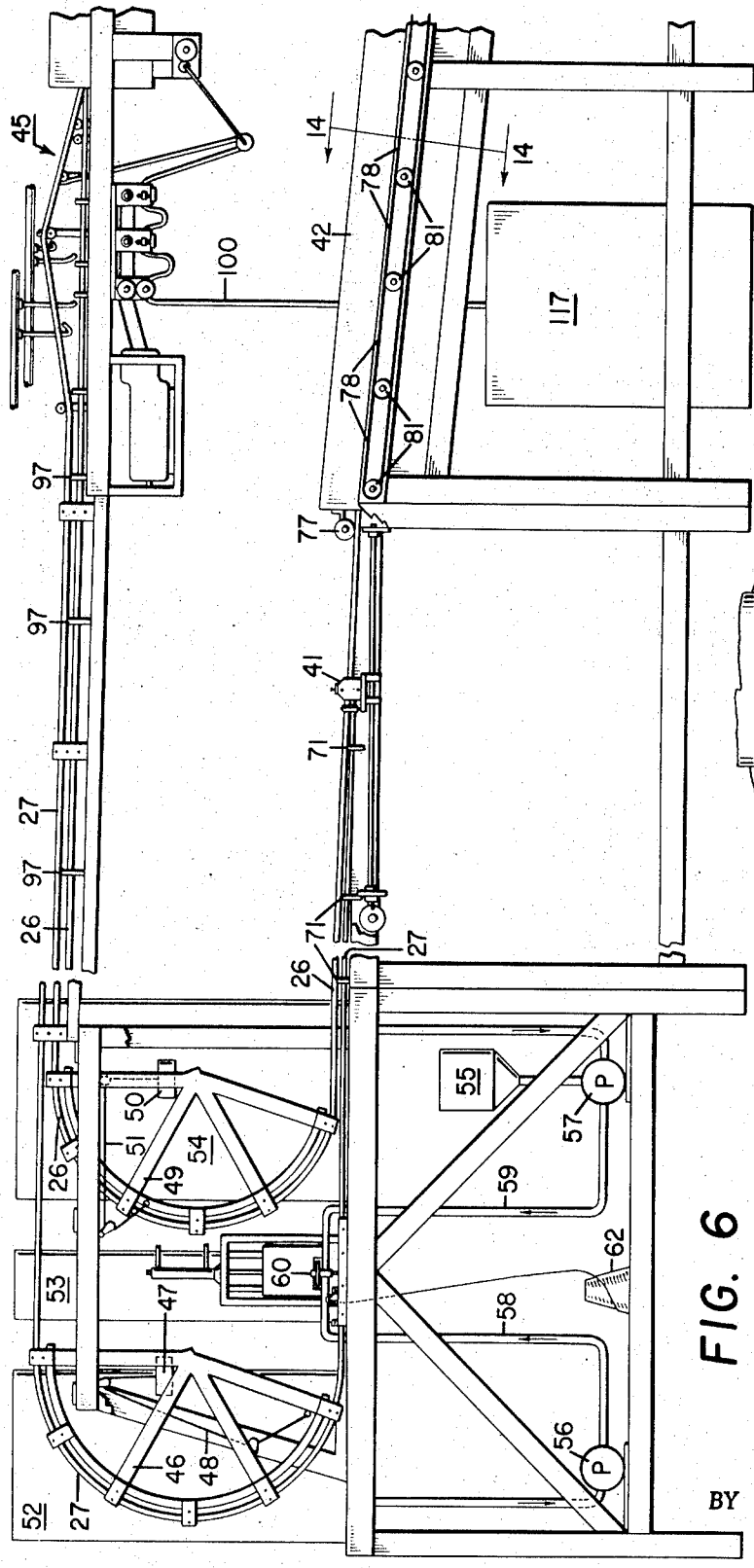


FIG. 6

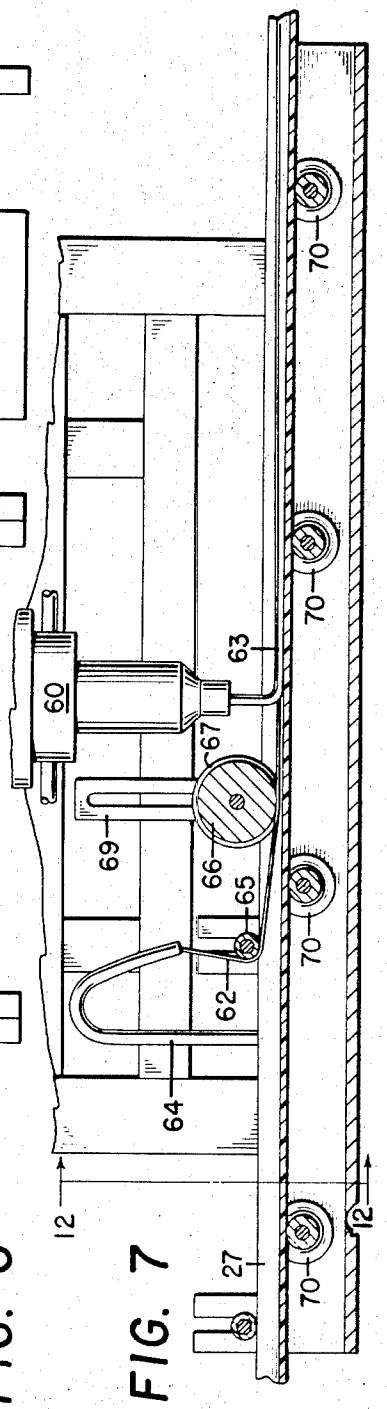


FIG. 7

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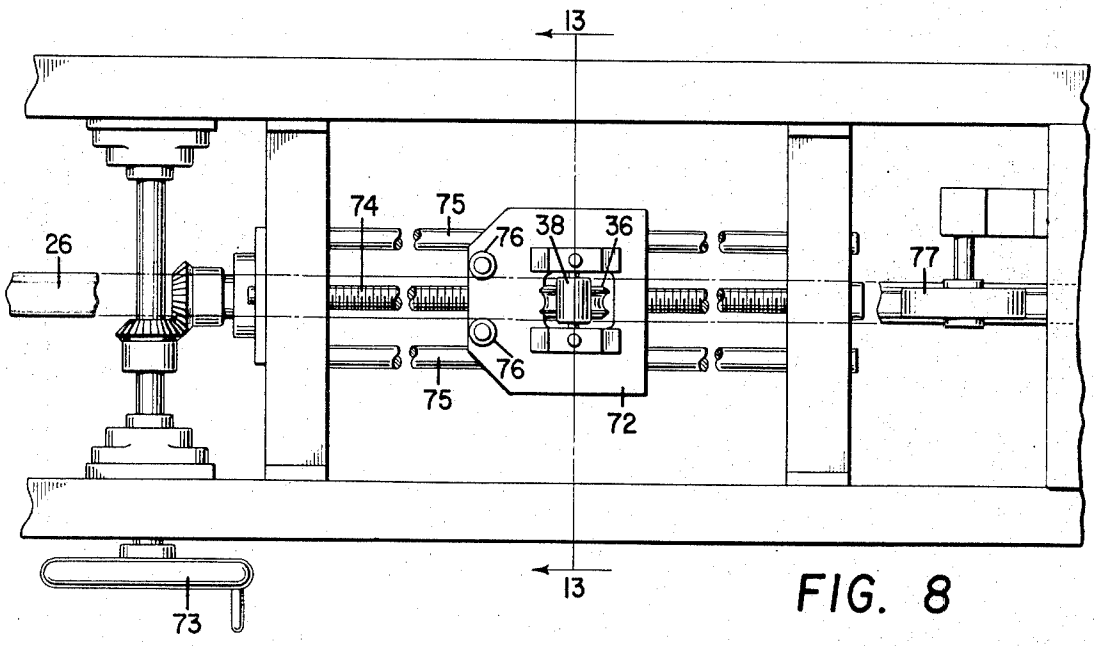


FIG. 8

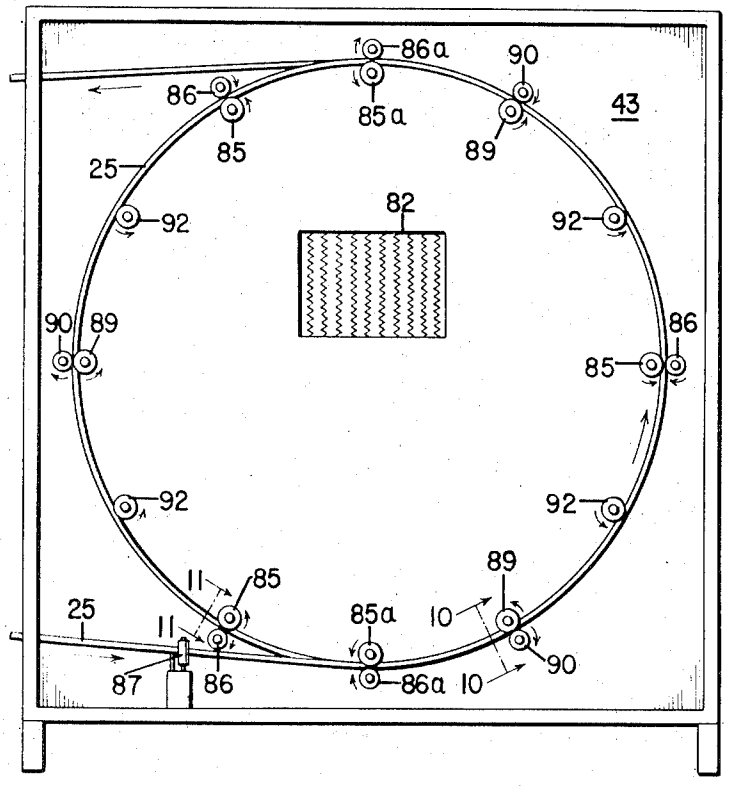


FIG. 9

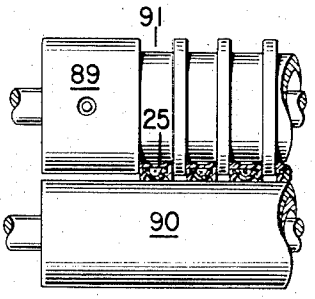


FIG. 10

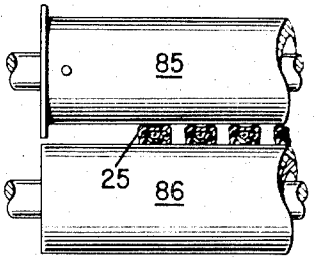


FIG. 11

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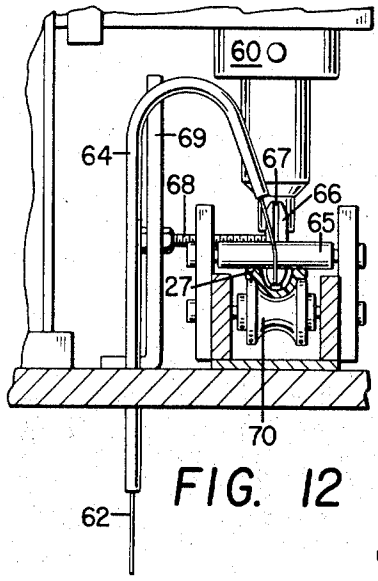


FIG. 12

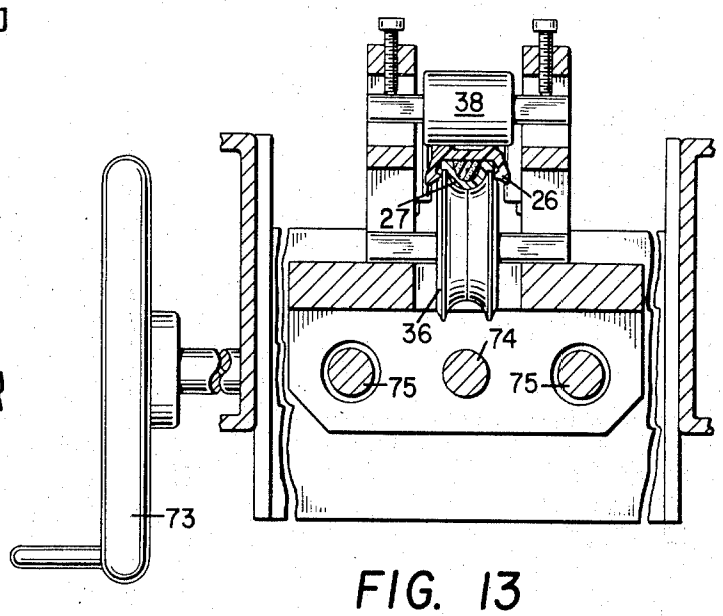


FIG. 13

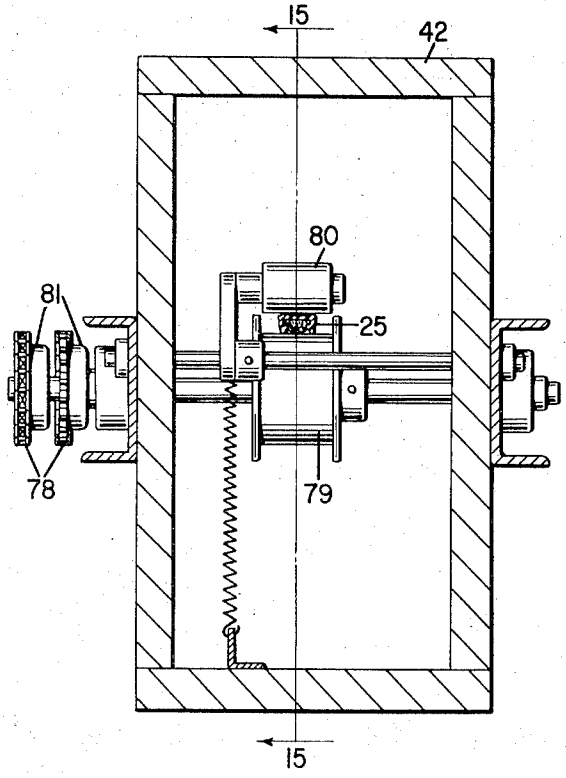


FIG. 14

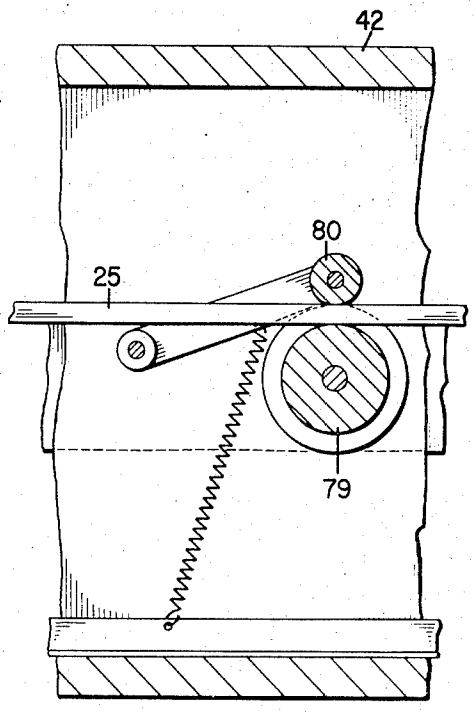


FIG. 15

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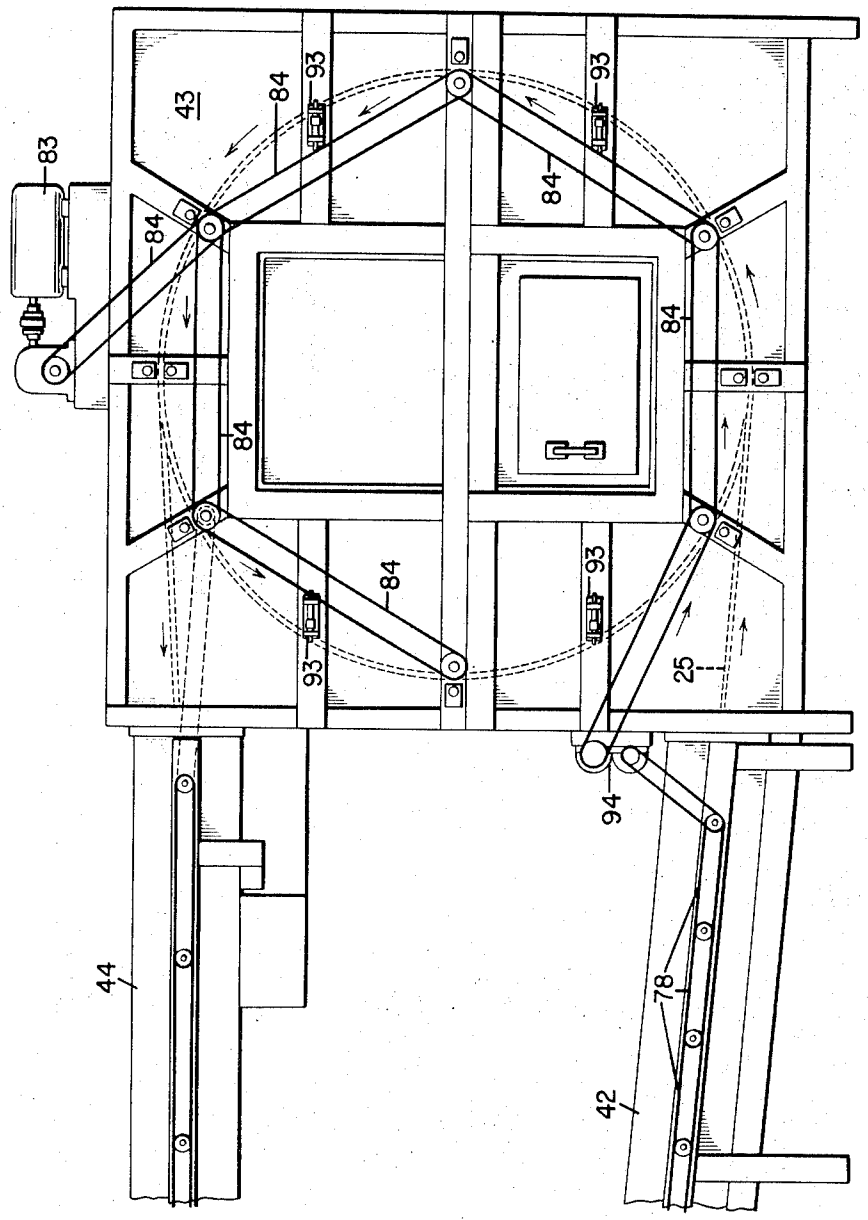


FIG. 16

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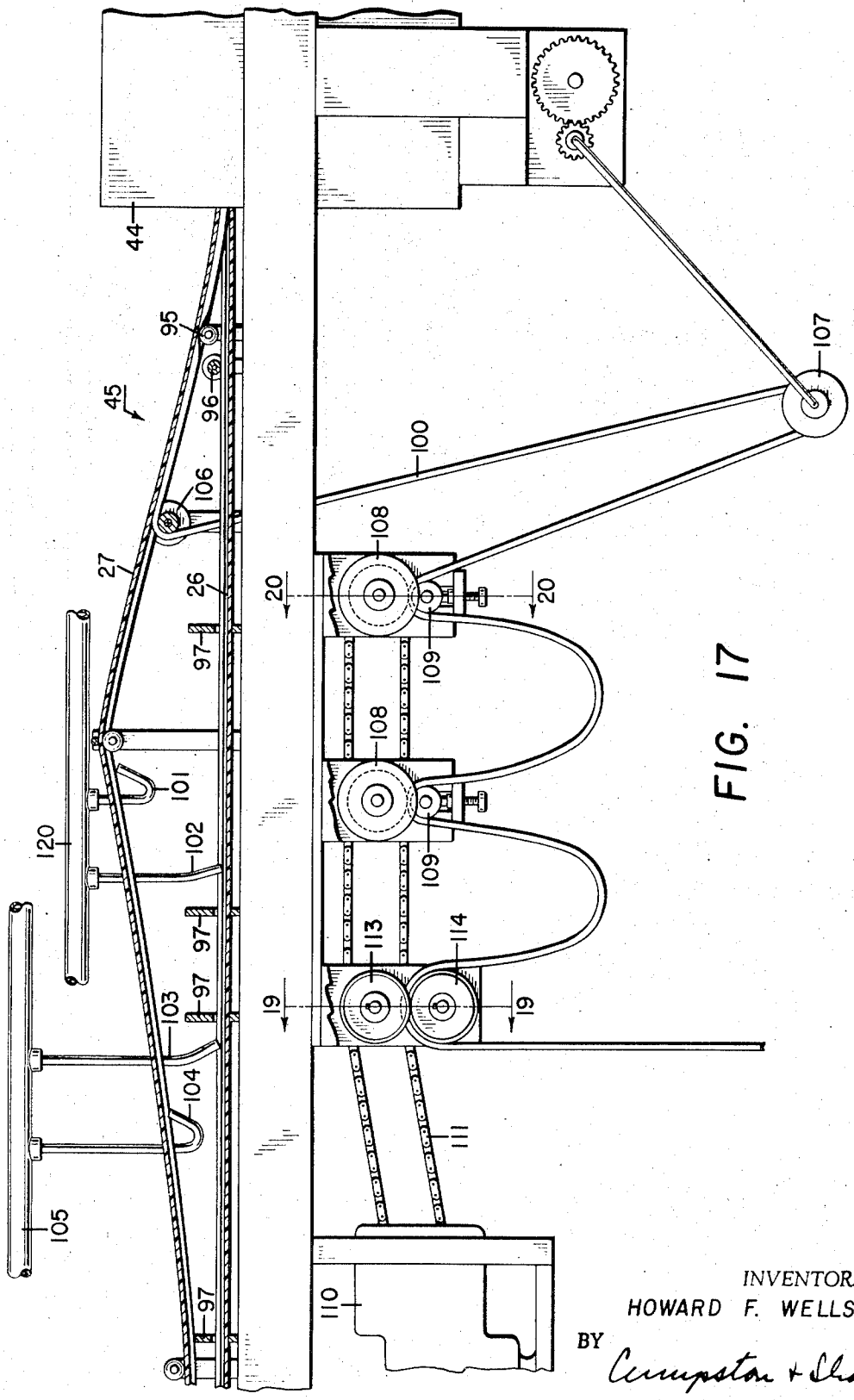


FIG. 17

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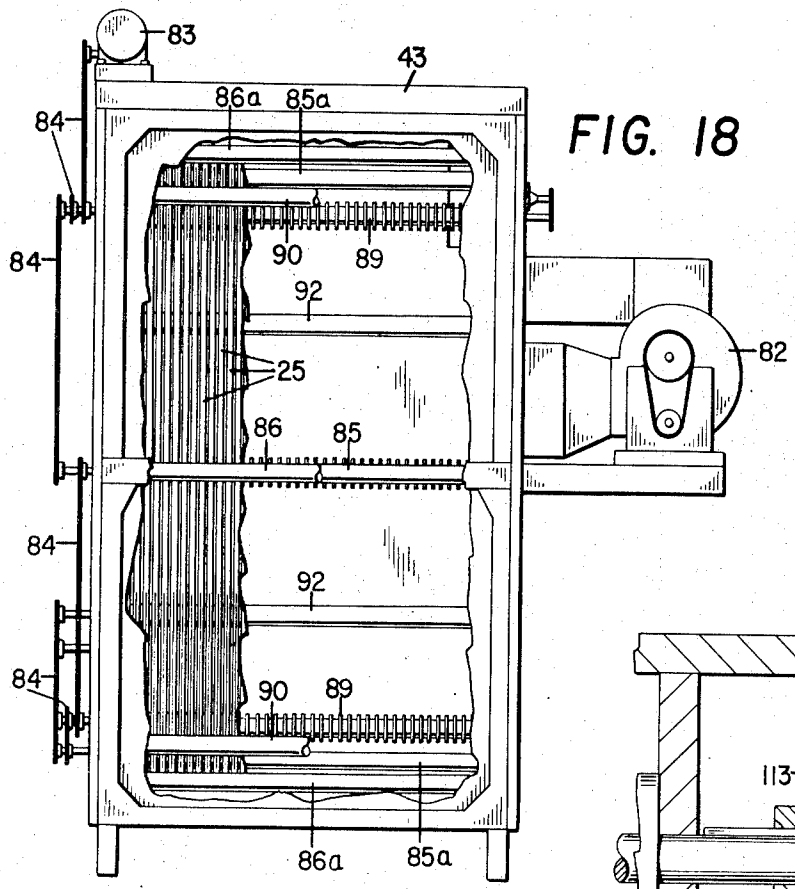


FIG. 18

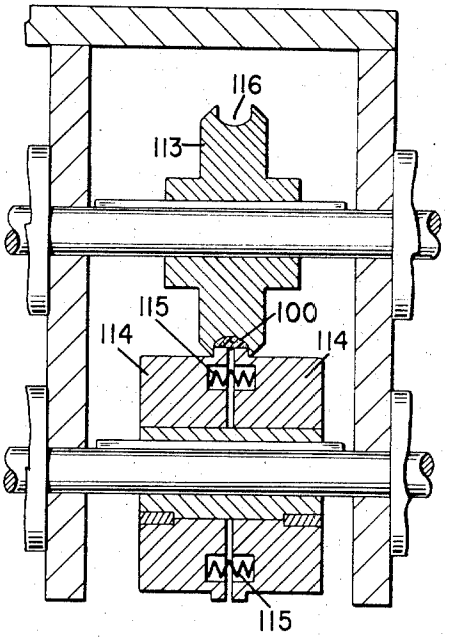


FIG. 19

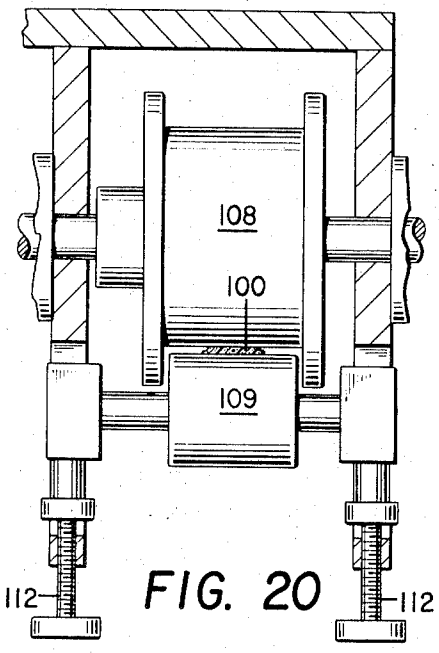


FIG. 20

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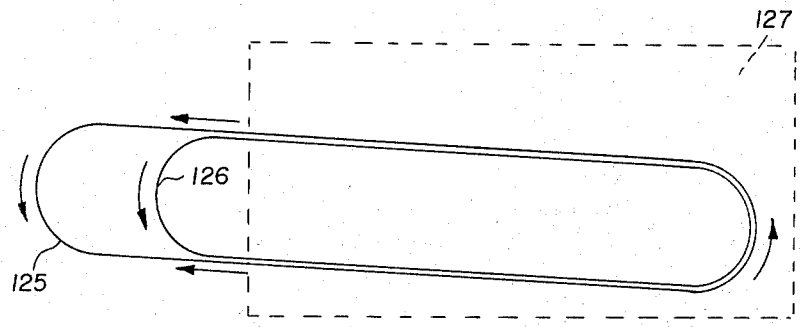


FIG. 21

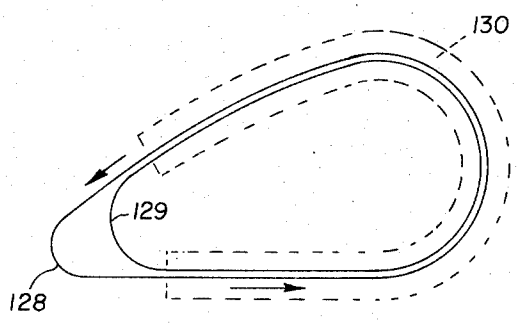


FIG. 22

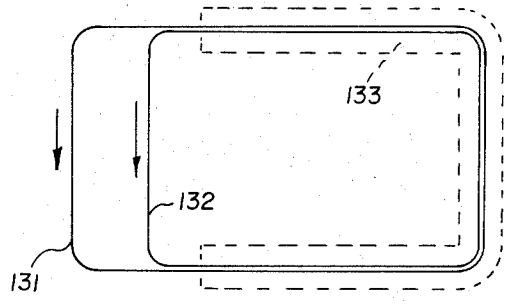


FIG. 23

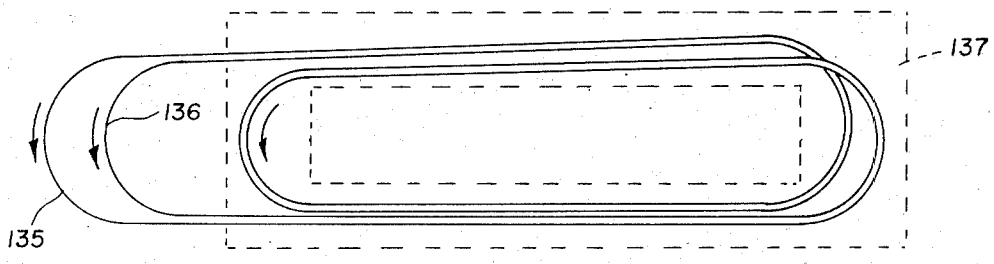


FIG. 24

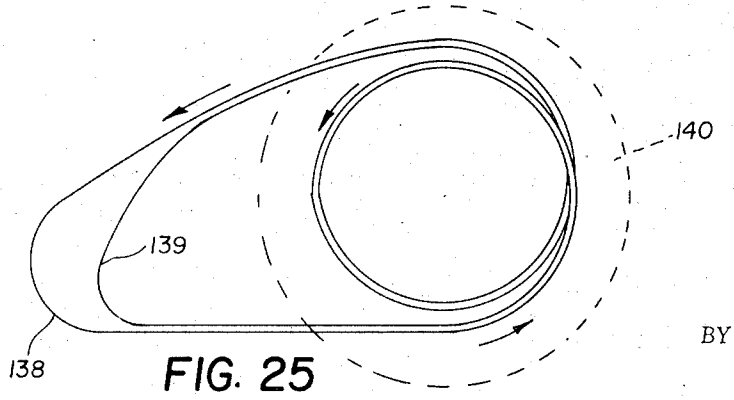


FIG. 25

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CONTINUOUS MOLDING APPARATUS

RELATED U.S. APPLICATION

Continuation-in-part of Ser. No. 460,404 filed June 1, 1965, now abandoned.

This invention relates to improved molding of foamable materials such as foamed plastics or synthetic resins and the like, and especially to continuous molding of such materials at speeds higher than any previously achieved by using a mold formed of continuous strips of relatively long lengths which are driven through a curved path for curing of the foamed product.

Continuous molding of foamed materials such as foamed polyurethane has been accomplished by prior art devices using molds formed of continuous strips, but the foaming and curing of the molded product has been accomplished only along a linear path, and continuous strip mold sections have required external support to contain and support the foamed product during its formation and curing. Also, foamed synthetic resins such as polyurethane presently require a minimum curing time during which they are heated to a desired temperature before they can be safely removed from the mold in which they were foamed. The curing time-temperature requirement has limited prior art devices to relatively slow molding speeds. Since lengths of foam-molded material are useful in large quantities for purposes such as weatherstripping in places such as around windows, doors, and in automobile bodies, and for uses such as windlaces, gaskets, seals, etc., it is important to be able to manufacture various configurations of continuous strips of foamed material in large quantities and at economical cost.

Accordingly, it is an object of this invention to mold foamed materials continuously in strip form at high speeds to provide economical molded products of high quality.

Another object of the invention is to mold foamed products continuously at high speeds in a relatively simple and inexpensive apparatus that is easily serviced and dependable and is reliable and economical of materials and space.

Another object of the invention is to mold continuous lengths of foamed strips in large quantities relatively quickly and cheaply.

Another object of the invention is to make maximum use of materials and space in molding continuous lengths of foamed plastic strips in large quantities at high speeds.

Another object of the invention is to mold foamed plastic strips continuously at high speeds in apparatus that is automatic and easily operated and serviced.

Other objects of the invention will be apparent hereinafter from the specification and from the recital of the appended claims. To these and other ends, the invention resides in certain improvements all as will be hereinafter more fully described, the novel features being pointed out in the claims at the end of this specification.

SUMMARY OF THE INVENTION

Generally, the invention comprises continuous molding of a length of foamed product such as polyurethane strip by use of relatively long continuous strip mold portions that are snap-fitted together to contain the foamed product and that are driven in interlocking

relation through a path longer than one half the length of either of the mold halves and including a curve of at least about 180°. Such a path is preferably arranged by disposing one mold half inside the other, and the path is preferably made relatively long by including several turns or loops. By such an arrangement, the mold can be filled and driven at a relatively high rate of speed, and the closed path extends for a sufficient length to provide the necessary curing time for the molded product.

The mold portions according to the invention are arranged to interlock with sufficient tenacity to maintain the foamed product within a closed cavity without requiring external support for the mold portions. Also, the mold according to the invention is preferably rigid enough when interlocked to bridge unsupported reaches of travel and is preferably flexible enough to be bent through a curve without stressing the foaming product so as to impair its development. Mold portions having such desirable characteristics are preferably extruded of synthetic plastic materials and bonded to form the necessary continuous lengths.

THE DRAWINGS

FIG. 1 shows a side elevation of continuous molding apparatus according to the invention;

FIG. 2 shows a plan view of the apparatus of FIG. 1;

FIG. 3 shows a partial end elevation of the left end of the apparatus of FIG. 1;

FIG. 4 shows a cross-section of mold portions according to the invention;

FIG. 5 shows the mold portions of FIG. 4 in the process of being closed together;

FIG. 6 shows a partial side elevation of the apparatus of FIG. 1 on an enlarged scale;

FIG. 7 shows an enlarged view partially in section of the mold filling station of the apparatus according to the invention;

FIG. 8 is a partial plan view showing a mold closing device according to the invention;

FIG. 9 shows a side elevation of a curing oven according to the invention with its side removed;

FIG. 10 shows a partial end elevation of mold guide rolls located in the oven of FIG. 9;

FIG. 11 shows a partial end elevation of mold drive rolls located in the oven of FIG. 9;

FIG. 12 shows a partial cross-sectional view of mold filling apparatus according to the invention taken along the line 12-12 of FIG. 7;

FIG. 13 shows a partial cross-sectional view of mold closing apparatus according to the invention taken along the line 13—13 of FIG. 8;

FIG. 14 shows a partial cross-sectional view of mold driving and guiding apparatus within an oven according to the invention taken along the line 14—14 of FIG. 6;

FIG. 15 shows a partial cross-sectional view of the mold guiding and driving apparatus of FIG. 14 taken along the line 15—15;

FIG. 16 shows a side elevation of a curing oven according to the invention;

FIG. 17 shows a partial side elevation of mold opening and cleaning apparatus and molded product processing apparatus according to the invention;

FIG. 18 shows a cut-away end elevation of the oven of FIGS. 9 and 16; its

FIG. 19 shows a partial cross-sectional view of a flashing trimmer according to the invention and taken along the line 19—19 of FIG. 17;

FIG. 20 shows a partial cross-sectional view of squeeze rolls according to the invention and taken along the line 20—20 of FIG. 17; and

FIGS. 21–25 are schematic side elevational views of various mold paths, curves and oven arrangements within the spirit of the invention.

DETAILED DESCRIPTION

The inventive apparatus is suited for continuous molding of a variety of materials in endless strip forms of many cross-sectional configurations. Such strips have many applications in weatherstripping, beading, trimming, gaskets, seals, and the like, and are demanded in quantity. Molding according to the invention can be applied to a variety of foamable materials including, but not limited to, synthetic resins such as polyurethane. In forming foamed products of such materials, a foamable mixture is deposited in a mold and expands to fill the mold by forming gaseous bubbles in the foamed material. To be self-sustaining and useful for practical applications, such foamed material is set or cured by heating such as at temperatures of from 170° to 180° F. for 10 to 15 minutes. Of course, the invention is not limited to any particular foamable material or curing time or temperature.

Throughout the drawings, corresponding parts are indicated by the same reference numeral. The apparatus illustrated in FIGS. 1–20 shows one preferred embodiment of the invention as applied to the molding of half-round polyurethane foam strips in continuous lengths. However, it is to be understood that the particular apparatus illustrated is only one of a great number of embodiments of the invention and that apparatus and method may take many other forms and steps, and products other than a half-round strip can be manufactured within the spirit of the invention.

THE MOLD

The inventive apparatus and method require a continuous mold, and a preferred embodiment of the mold itself, as best shown in FIGS. 4 and 5, will be described before the apparatus and method are taken up.

The illustrated mold 25 is formed of two sections or portions 26 and 27, one of which, such as mold portion 27, is preferably formed as a trough for continuously receiving a bead of foamable material. It is preferred that mold portions 26 and 27 be configured to snap fit together in an interlocking relation, and to this end, mold portion 27 is provided with side flanges 28 extending outward adjacent its edges, and mold portion 26, a section 32 of which forms a cover for the trough of mold portion 27, is provided with side walls 29 extending downward over flanges 28. Side walls 29 are preferably provided with hook portions 30 extending inward under flanges 28 when the mold portions are interlocked together. Raised ribs or ridges 31 on mold portion 26 strengthen the juncture of side walls 29 with cover portion 32 and provide bearing surfaces for various drive and guide means in the inventive apparatus.

From the lower extremities 33 of side walls 29, a preferably tapered surface 34 leads to hook portion 30 to provide a surface by which the side walls 29 of mold portion 26 can be spread apart for opening or closing the mold 25. The spreading apart of side walls 29 and hook portions 30 is best shown in FIG. 5 where a central portion 35 of wheel 36 supports the trough portion of mold portion 27, while the rim portions 37 of wheel 36 force apart the side walls 29 of mold portion 26 as it is pressed downward by roller 38. Mold portions 26 and 27 can be separated merely by being forced apart by rollers at an appropriate point in their travel, and it is possible within the spirit of the invention to snap fit these mold portions together without the aid of spreading wheel 36. Also, other interlocking configurations are possible within the spirit of the invention.

It is preferred that mold portions 26 and 27 be extruded of a synthetic plastic resin such as polyolefins including polyethylene, polypropylene, or mixtures of these or other materials. A satisfactory mold material is essentially an alloy of propylene and ethylene and is preferably formed as a smooth-surfaced extrudate. The preferred material for a mold according to the invention has a waxy, unctuous surface for ready release of the molded product and is preferably not only rigid enough for a secure interlock between the mold portions to retain the foaming material within the mold cavity but also flexible enough to be driven through the required curved path. Extruded mold portions 26 and 27 have their ends welded or bonded together to form continuous lengths according to the invention.

MOLD-HANDLING METHOD AND APPARATUS

Turning now to mold handling according to the invention, the illustrated embodiment of the apparatus according to the invention is shown in its entirety in FIGS. 1 and 2, and the other views show various details of this apparatus.

Referring to FIGS. 1 and 2, the bead of foamable material is deposited in the mold at a filling station 40. The mold portions are closed together and interlocked at a mold closing station 41, the interlocked mold portions are then driven through a first oven 42 into a main oven 43 where they move through a helical path, and then into a third oven 44. After emerging from oven 44, the mold portions are separated at a separating station 45, and the cured product is removed from the mold. Of course, the arrangement of ovens and paths can be varied within the spirit of the invention.

The downward incline or slope of the mold in passing through oven 42 is preferred to assist in allowing gas to escape freely from the foaming product contained within the mold. The linear traverse of the mold through oven 42 allows the material to foam to fill the mold cavity and gives the material a preliminary curing or gel so that it can bend through the helix in oven 43 without any detriment to the foamed product. Generally, a foam such as polyurethane must be handled gently and not stressed or disturbed during curing to produce the best quality finished product. In this connection, the helical path through oven 43, as more fully described below, is preferred in that the mold and the curing product contained within its cavity are bent about a constant radius during a considerable length of travel for undisturbed curing.

In considering the details of the illustrated embodiment of apparatus according to the invention, the sequence of the inventive method will be followed from

the point of filling the mold to the point of removal of the cured product.

Filling station **40** is located at the open portion of the mold path where mold portions **26** and **27** are separated, and station **40** is near the left end of the apparatus illustrated in FIGS. **1** and **2**. FIG. **3** shows an end elevation of this end of the apparatus with bottom or trough mold portion **27** guided over tensioning arc **46** which is urged outward by weight **47** acting on cable **48** to tighten or remove slack from mold portion **27**. A similar tension arc **49**, best shown in FIG. **6**, is biased by weight **50** pulling on cable **51** to tension upper mold portion **26**.

As shown in FIG. **6**, tanks **52–55** are provided for various compounds, solvents, or ingredients for providing a foamable mixture to be molded according to the invention. Of course, such tanks will contain various materials depending upon the foamed product, and for the illustrated embodiment of the invention, contain the materials necessary for a foamable polyurethane. Pumps **56** and **57** force ingredients through lines **58** and **59** to mixing head **60** where the materials are accurately mixed and metered for delivery to trough mold portion **27**. Also, for many applications of strips molded according to the invention, it is desirable to embed a strengthening cord, a wire, or mesh wire in the foamed product, and to this end, a winding of cord **62** is positioned so that the cord is fed to the filling station for inclusion within the molded product.

The depositing of foamable mixture in mold portion **27** is best shown in FIGS. **7** and **12**. Mold portion **27** is moved through the illustrated filling station with uniform speed, and mixing head **60** is arranged for accurately metering a bead **63** of material to be delivered to the trough of mold portion **27**. Cord **62** is guided through tube **64**, under roller **65**, and under guide wheel **66** for accurate positioning, guide wheel **66** has a peripheral slot **67** for steering cord **62** and is preferably adjustable both vertically and horizontally by means of threaded rod **68** and adjustment bracket **69**. Support rollers **70** which are preferably shaped to conform to the outside of mold portion **27** carry mold portion **27** continuously past mixing head **60** for receiving bead **63** of mixture and cord **62**. Driving means for advancing the mold are preferably located beyond filling station **40** as will be described below. The bead **63** of foamable material begins to foam and expand as soon as deposited in mold portion **27**, so that its volume increases as it moves toward mold closing station **41**.

As best shown in FIG. **6**, upper mold portion **26** is guided to a position immediately above lower mold portion **27** as the mold portions approach mold closing station **41**. In such a relationship, mold portions **26** and **27** are disposed for snap-fitting together in an interlocked relation.

It is preferred according to the invention that the foamable material be expanded to a volume sufficient for filling the closed mold at the point at which the mold portions are interlocked together. This allows the escape of gasses formed during the foaming process and yet accomplishes mold closure before the volume of the foamed material exceeds that of the mold cavity, so that the mold portions are readily snap-fitted together. Thus, for various molding operations and speeds, it is desirable that the mold closure station **41** be adjustable longitudinally of the mold path, and it is possible within the spirit of the invention that mold closure take place within oven **42** on the downwardly inclined reach leading to the helical path in the main oven **43** (FIG. **1**). Until the location for optimum mold closure is reached, mold portions **26** and **27** are held apart and guided by guides **71**.

The details of mold closure are best shown in FIGS. **5**, **8** and **13**. FIG. **8** shows the longitudinally movable closure carriage **72** on which is mounted a mold closure device according to the invention. Carriage **72** is moved longitudinally by means of crank wheel **73** and driven screw **74** while supported by guide rods **75**. Such longitudinal adjustment allows positioning of the mold closure device at precisely the desired point at which the volume of the foaming material equals that of the mold cavity.

Mold portions **26** and **27** can be snap-fitted together by forcing them into engagement with each other, but it is preferred to spread the side walls of mold portion **26** as the mold portions are pressed together for smoother snap-fitting. To this end, generally vertically disposed guide rolls **76** align mold portion **26** with spreading wheel **36** which operates as described above and as shown in FIGS. **5**, and **13**. Simultaneously with the spreading of its side walls, mold portion **26** is pressed downward by vertically adjustable roller **38** into engagement with lower mold portion **27** which is supported by the concave periphery of roller **36** so that as the mold portions leave rollers **38** and **36**, they are in interlocking engagement with each other. Of course, other mold closure devices can be used within the spirit of the invention, it merely being preferred that the mold portions be forced into a snap-fitted, interlocking relation.

After being snap-fitted into a closed position, the mold containing the foaming mixture is guided into downwardly inclined oven **42** as shown in FIGS. **1** and **6**. It is preferred that the path of the mold through oven **42** be downwardly inclined to facilitate the escape of gas from the foaming product, but the invention can be practiced without using such an incline.

As best shown in FIGS. **6**, **14**, and **15**, mold **25** and its contents are driven and guided through oven **42**. Guide wheel **77** controls the entry of mold **25** into oven **42**, and chains **78** powered by drive motor **83** through gearing **94** are arranged along the outside of oven **42** for driving the mold at various contact points throughout oven **42**. A plurality of driven rollers **79** and associated pressure rollers **80** grip mold **25** at spaced locations along oven **42** and guide and drive it forward. Pulleys **81** spaced along the outside of oven **42** indicate the points at which driven rollers **79** are located within oven **42** for advancing mold **25**. From this and from FIG. **15**, it is clear that mold **25** is self-supporting from one drive roller **79** to the next, and that mold **25** is sufficiently rigid to span the reach between rollers **79**. Since the foaming material places some separating pressure on the two portions of mold **25**, sufficient interlocking strength to retain the foamed material is desirable for the linear run through oven **42**.

Preferably, a central forced air heating system **82** (FIGS. **2** and **18**) is arranged for circulating heated air not only to oven **43**, but to ovens **42** and **44** as well. As best shown in FIG. **16**, heat from oven **43** can be forced

into oven **42** through their open connection with each other.

After passing through oven **42**, mold **25** enters oven **43** best illustrated in FIGS. **9**, **16**, and **18**. By this time, the foaming material in mold **25** has preferably completed its expansion and has achieved a sufficient gel or set so that it can be bent into a curved path. The foamed product at this point requires several more minutes of curing at a temperature of about 180° F. before it is ready to be removed from mold **25**. As mentioned above, heating unit **82** is preferably arranged for forcing heated air in thorough circulation throughout oven **43** to accomplish curing of the foamed product.

Because of the flexibility of mold **25**, it can be bent through a closed curve and is preferably driven within oven **43** in a helix each turn of which is of uniform radius. This allows mold **25** to be bent upon its entry into oven **43** into a radius of curvature constantly maintained throughout its travel through the helix in oven **43**. The result is that one gentle bend is applied to mold **25** and its foamed contents for minimum stress and agitation of the contents, and such bend is maintained undisturbed for several minutes of travel through oven **43**.

Mold **25** is preferably driven through the helix in oven **43** by a drive motor **83** powering chains **84** which drive rollers **85** extending through oven **43**. As shown in FIG. **16**, six driven rollers are arranged within oven **43**, but of course, any suitable number of drive rollers can be used. As shown in FIGS. **9** and **11**, each roller **85** is provided with an associated pressure or counter roller **86** that is preferably spring loaded to urge mold **25** against drive rollers **85**.

In adjusting the lateral spacing of each convolution of the mold in its helical path in oven **43**, mold **25** is first guided into an initial position by generally vertically disposed guide roller **87** shown in FIG. **9**. From guide **87**, mold **25** is bent into its radius of curvature between the lowermost set of idler support rolls **85***a* and **86**a and driven guide rolls **89** and **90** where the mold enters the first of a plurality of channels **91** in guide roll **89** as best shown in FIG. **10**. Pressure roll **90** urges mold **25** against guide roll **89** and keeps mold **25** within the desired slot or channel in guide roll **89**. It is preferred that other sets of channeled guide rolls **89** and associated pressure rollers **90** be provided about the helix in oven **43**, and such other sets are shown at 120° angles from each other. Of course, additional or fewer guide rolls can be used, and guide rolls can be idled as well as driven. Also, it is possible within the spirit of the invention for each turn of the mold **25** in the helix in oven **43** to bear against each successive turn without the spacing provided by guide rolls **89**. However, heating is enhanced by the resulting spacing, and deviation from the desired path is prevented by selective use of guide rolls **89**. Turns of the mold **25** in the helix of oven **43** are best shown in the partially cutaway view of FIG. **18**.

It has been found that extrudate mold portions according to the invention stretch or elongate in use, and it is desirable to take up the resulting slack in mold **25**. A preferred location for such take-up is in oven **43**, and take-up rolls **92** are provided inside the helix for urging mold **25** outward toward a slightly larger radius. Extremely strong bias springs or preferably pneumatic bias means are preferred for forcing the many turns of the helix outward. Such bias means **93** for take-up rolls **92** are shown in FIG. **16**.

As mold **25** traverses the many turns of the helix in oven **43**, it moves from left to right as illustrated in FIG. **18** and leaves oven **43** at the left side as best shown in FIG. **2** and enters oven **44**. Oven **44** is similar to previously described oven **42** in providing drive means for advancing mold **25** and in being in communication with central heating source **82** for continuing the heat curing of the foamed product in mold **25**. The drive means within oven **44** is preferably powered by drive means **83** previously described for driving the mold through the helix in oven **43**.

After leaving oven **44**, mold **25** enters separating station **45** best shown in FIGS. **6**, **17**, **19**, and **20**. As best shown in FIG. **17**, trough mold portion **27** and cover mold portion **26** are separated by being forced apart by separating rollers **95** and **96**. From this point onward, mold portions **26** and **27** are guided through the foaming and curing cycle. To this end, guides **97** (FIG. **6**) direct each respective mold portion toward tensioning arcs **46** and **49** where their paths are separated.

After opening the mold and removing the cured product **100** therefrom as illustrated in FIG. **17**, it is preferred that the mold portions be cleaned before running through another cycle. For this purpose, jets **101** and **102** direct air from air line **120** against mold portions **27** and **26** respectively to remove any flashing or scrap material remaining in the mold. It is also preferred that jets **103** and **104** direct a cleaning fluid from line **105** into the cavities of the separated mold portions. It is preferred that such cleaning fluid spray be directed into the corners of mold cover portion **26** to remove any flashing bits therein, and one preferred cleaning fluid is an extremely fine spray of a silicone release fluid which not only cleans the mold, but coats it with a silicone and wax residue which makes mold opening and release of the molded product easier on the next molding cycle. Of course, a variety of mold cleaning and coating operations can be accomplished as desired at the mold opening station **45**, and the invention is not limited to any particular cleaning fluid or method or coating operation.

In addition to the previously described tension arcs **46** and **49** for tensioning and taking up slack in mold portions **26** and **27**, it is possible to introduce other or additional such slack take-up devices conveniently between mold opening station **45** and filling station **40**. Take-up devices biased by weights can conveniently be arranged immediately beyond mold opening station **45**.

As best shown in FIG. **17**, cured product **100** is led around pulley **106** for removal from mold portion **27** and is then guided under tension pulley **107** which is preferably biased downward to place product **100** under predetermined tension.

Subsequent to its removal from the mold, cured product **100** is preferably trimmed to remove flashing and squeezed to destroy any shrinkable intact gas bubbles remaining within it. These operations can be done in any desired order, and in the illustrated embodiment, the product is first squeezed, and then trimmed.

Squeezing of the cured product is preferred because occasionally intact bubbles or relatively hot gas remain in the cured product, and as such gas bubbles cool, they

can produce shrunken spots in the final product which detract from its appearance and value. Squeezing can rupture any such bubbles, prevent any such shrinking, and result in a more attractive and functional product.

In the illustrated embodiment, a pair or flanged squeeze rolls **108** and associated pressure rolls **109** are arranged in series for successively squeezing the cured product **100**. It is preferred that squeezers and trimmers be driven by a single drive unit **110** transmitting power through chain **111** so that the squeezers and trimmers are all driven at a uniform speed.

As best shown in FIG. **20**, pressure roll **109** is preferably vertically adjustable for a predetermined tension against flanged squeeze roll **108** to give the desired squeezing or crushing treatment to the foamed strip. Such adjustment is preferably accomplished by adjustment bolts **112**.

Trimming is preferably accomplished by a continuous trimming shear preferably having a boundary wheel **113** and a pair or shearing wheels **114** best illustrated in FIG. **19**. Shearing wheels **114** are preferably biased apart from each other by springs **115** for urging the shearing wheels **114** against the inside edges of boundary wheel **113** with predetermined force. As wheel **113** rolls with wheels **114**, the edges of the channel **116** in wheel **113** sever the flashing off product **100** and leave its edges trimmed to a predetermined uniform dimension. After trimming, the finished product **100** is preferably allowed to drop downward into a box **117** or other container, but of course, product **100** could be wound or spooled after trimming as desired.

It can be seen that according to the invention a relatively long length of mold filled with curing product can be driven through ovens **42–44** so that molding can proceed at a relatively high speed and the desired curing time can still be obtained. Thus, with **48** turns of mold in a helix of 4 foot radius, in addition to the mold running through ovens **42** and **44**, it has been possible to operate the illustrated apparatus at molding speeds of 100 feet per minute with curing times of 12 minutes for the foamed product. Although such speeds at present require over 1,000 feet of mold, they exceed by far any speed obtained with prior art apparatus. Furthermore, with product improvement, and different or improved curing, it may be possible to reduce the total length of mold required or speed up the molding rate with the inventive apparatus. Although a relatively long length of mold is required, according to the invention, such a mold length is not unreasonably burdensome or difficult to handle because of the self-supporting and interlocking and flexing characteristics of the mold, none of which were available with prior art structures known to the applicant.

The apparatus of FIGS. **1 – 20** uses one of several preferred mold paths providing a curve in the closed portion of the path. Other preferred mold paths and oven arrangements are illustrated schematically in FIGS. **21–25**. Variations on these arrangements are also possible.

Outer mold part **125** follows an oblong continuous loop around inner mold part **126** as shown in FIG. **21**. An oven **127** is arranged to heat the closed portion of the path of mold parts **125** and **126**. The initial reach of the closed portion of the mold path is downwardly inclined into oven **127** to allow the gaseous escape from the foam product as described above. The curves at the ends of the path for mold parts **125** and **126** are of approximately equal diameter and extend through substantially 180°.

The curve-within-a-curve arrangement shown in FIG. **21** is preferred to make the closed portion of the mold path a maximum length relative to the total mold length. This conserves on the required mold, space and heating equipment.

The mold path illustrated in FIG. **22** is similar, but the curvature radii differ at opposite ends of the closed loops. Outer mold part **128** forms a continuous oblong loop around inner mold part **129**, and oven **130** is generally horseshoe shaped to enclose the closed portion of the mold travel. Ovens or heating means along the closed portion of the mold portion can be unitary, multiple, or arranged in a variety of ways to cure the foamed product.

In FIG. **23**, outer mold part **131** follows an approximately rectangular path around inner mold part **132**. Such an arrangement requires relatively small radius turns separated by linear lengths of travel. Instead of approximately 180° turns at the ends of the oblong as illustrated in FIG. **1**, such ends include two 90° turns. Variations on the curvatures in the mold path according to the invention can range through any curves between FIGS. **21** and **23**, and the pairs of 90° turns at the ends of the path in FIG. **23** are equivalent to the 180° turns at the ends of the path of FIG. **21**. Oven **133** of FIG. **23** is formed in an approximate U shape to heat the closed portion of the mold path. Oven **33** can readily be divided into three linear ovens if desired.

FIG. **24** shows a multi-loop version of the mold path of FIG. **21**. Outer mold part **135** forms a continuous loop around inner mold part **136**, and at least one doubling back of such loop is provided. Oven **137** is arranged in an open-centered rectangle to surround the closed portion of the mold path. The general path illustrated in FIG. **24** can save space and increase efficiency over the helical path version illustrated in FIGS. **1–20**. The oblong oval loop of the closed portion of the mold path can be repeated for any desired number of turns, and a greater length of mold can be run through such an oblong path for the overall height and width of the machine than can be accommodated in the circular helical path previously described.

FIG. **25** shows a multi-loop closed portion of mold path similar to the single loop path of FIG. **22**. Outer mold part **138** forms a closed loop around inner mold part **139**, and a generally cylindrical oven **140** encloses the closed portion of the mold path. Complete loops of interlocked travel of the mold can be repeated for as many loops as desired. The relatively large radius of the closed loop portion of the mold travel allows gentle bending of the mold while the foamed product is contained within the mold cavity. The relatively smaller radii of the curves at the open portion of the path is possible since the foamed product is not contained within the mold cavity at that point.

Persons wishing to practice the invention should remember that other embodiments and variations can be adapted to particular circumstances. Even though one point of view is necessarily chosen in describing and claiming the invention, this should not inhibit broader or related applications within the spirit of the inven-

tion. For example, many different heating arrangements and many mold paths, mold driving equipment, guides, rollers, tensioning devices, mold separating and closing equipment, mold and product cross sections, and mold cleaning gear can be used within the spirit of the invention.

I claim:

1. In an apparatus for continuous molding of a foamed product, said apparatus including first and second endless strip mold portions relatively configured to snap-fit together in interlocking relation to form an elongate mold cavity for said foamed product, and means for advancing said mold portions respectively through a path having an open portion where said mold portions are separated and a closed portion where said mold portions are interlocked, the improvement comprising:

a. said interlocked mold portions being capable of containing said foamed product without external support;

b. said closed portion of said path including a curve of at least substantially **180°**;

c. one of said mold portions being disposed radially inside the other throughout said closed portion of said path; and

d. said closed portion of said path being longer than one half the length of either said first or second mold portions.

2. The apparatus of claim **1** wherein said first and second mold portions are each formed of flexible synthetic plastic material flexible enough to be bendable in at least one plane.

3. The apparatus of claim **2** wherein said first and second mold portions are formed of extrusions joined in continuous respective lengths.

4. The apparatus of claim **1** wherein said closed portion of said path comprises a helix.

5. The apparatus of claim **1** wherein heating means is arranged along said closed portion of said path for curing said foamed product.

6. The apparatus of claim **1** wherein said closed portion of said path includes regions in which said interlocked mold portions are unsupported by external means.

7. The apparatus of claim **1** wherein said first mold portion is configured to define a long trough having side flanges extending outward adjacent its edges, and said second mold portion is configured to define a cover for said trough having side walls adapted to engage said flanges.

8. The apparatus of claim **7** wherein said side walls are configured in cross section to define inwardly directed hooks adapted for engaging said flanges.

9. The apparatus of claim **8** wherein said side walls are tapered from their hook portions to their free extremities.

10. The apparatus of claim **9** including means for spreading apart said side walls to receive said flanges therebetween, and means for pressing said mold portions together as said side walls are spread apart for closing said mold portions in said interlocking relation at the beginning of said closed portion of said path.

11. The apparatus of claim **1** including means located at said open portion of said path for depositing foamable material in one of said mold portions.

12. The apparatus of claim **11** including means for guiding a continuous strand into said foamable material so that said strand is embodied in said foamed product.

13. The apparatus of claim **1** wherein said closed portion of said path includes a downwardly inclined reach approaching said curve.

14. In an apparatus for continuous molding of a foamed product, said apparatus including first and second endless strip mold portions relatively configured to snap-fit together in interlocking relation to form an elongate mold cavity for said foamed product, and means for advancing said mold portions respectively through a path having an open portion where said mold portions are separated and a closed portion where said mold portions are interlocked, the improvement comprising:

a. said first and second mold portions being formed of respective extrusions of flexible, synthetic material joined in continuous lengths;

b. said interlocked mold portions being capable of containing said foamed product without external support;

c. said closed portion of said path including a curve of at least substantially **180°**;

d. one of said mold portions being disposed radially inside the other throughout said closed portion of said path;

e. said closed portion of said path being longer than one half the length of either said first or second mold portions;

f. means located at said open portion of said path for depositing foamable material on one of said mold portions; and

g. heating means arranged along said closed portion of said path for curing said foamed product.

15. The apparatus of claim **14** wherein closed portion of said path includes a helix.

16. The apparatus of claim **14** wherein said first mold portion is configured to define a long trough having side flanges extending outward adjacent its edges, and said second mold portion is configured to define a cover for said trough having side walls adapted to engage said flanges.

17. The apparatus of claim **16** wherein said side walls are configured in cross section to define inwardly directed hooks adapted for engaging said flanges.

18. The apparatus of claim **17** wherein said side walls are tapered from their hook portions to their free extremities, and including means for spreading apart said side walls to receive said flanges therebetween, and means for pressing said mold portions together as said side walls are spread apart for closing said mold portions in said interlocking relation at the beginning of said closed portion of said path.

19. The apparatus of claim **14** including means for guiding a continuous strand into said foamable material so that said strand is embodied in said foamed product.

20. The apparatus of claim **14** wherein said closed portion of said path includes a downwardly inclined reach approaching said curve.

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