June 18, 1968 R. E. O'BRIEN ET AL 3,388,625

SHEET-FORMING AND POST-FORMING TRIM METHOD AND APPARATUS

Original Filed July 15, 1965 5 Sheets-Sheet 1

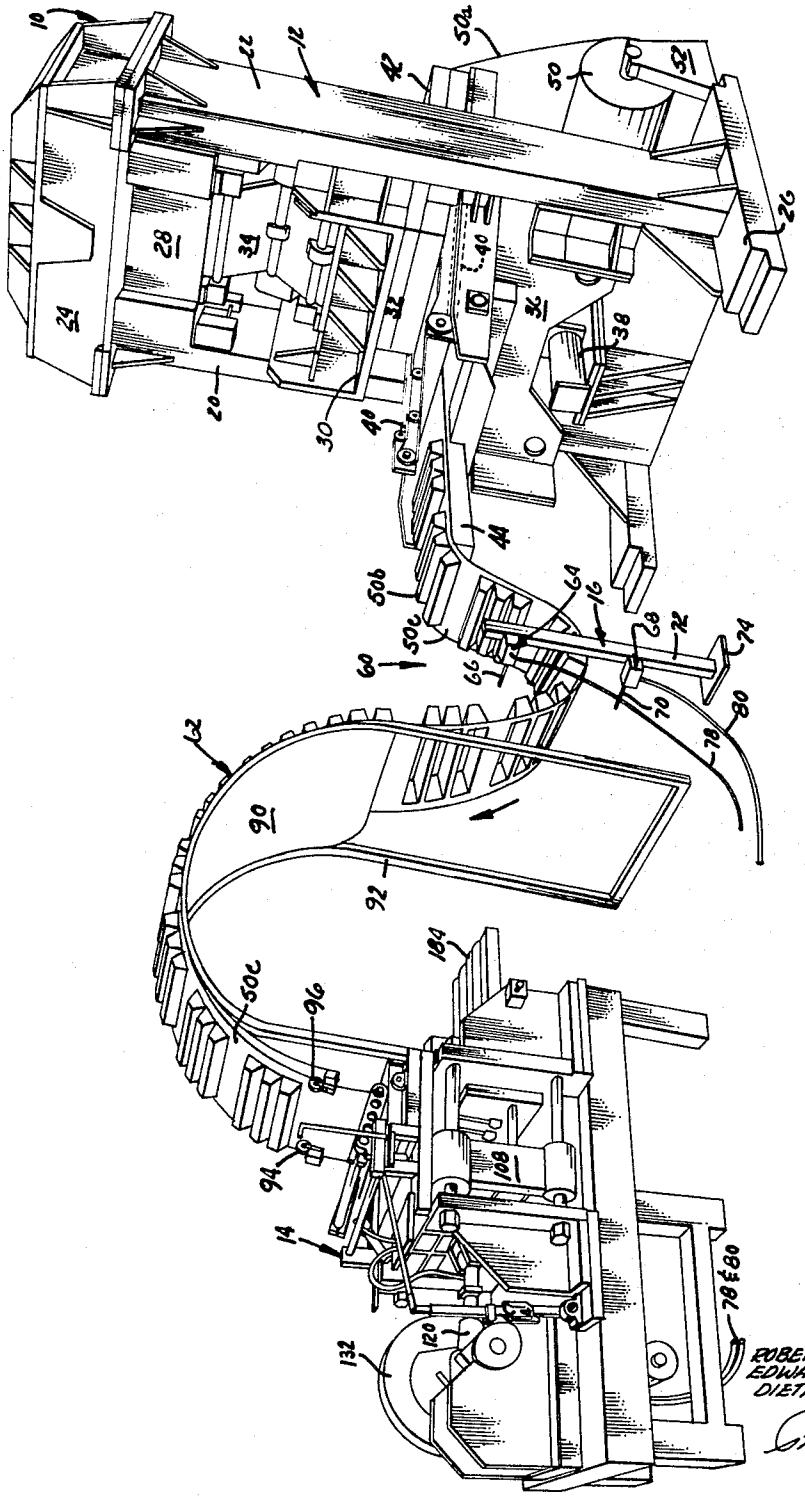


FIG. 1.

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SHEET-FORMING AND POST-FORMING TRIM METHOD AND APPARATUS

Original Filed July 15, 1965 5 Sheets-Sheet 2

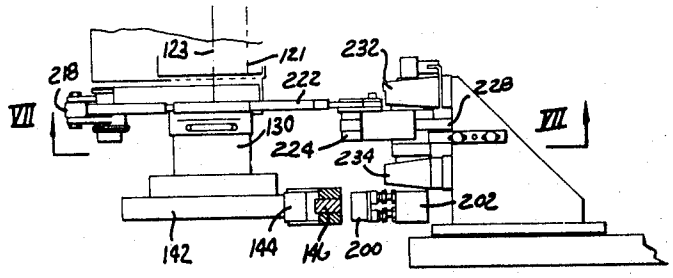


FIG. 6

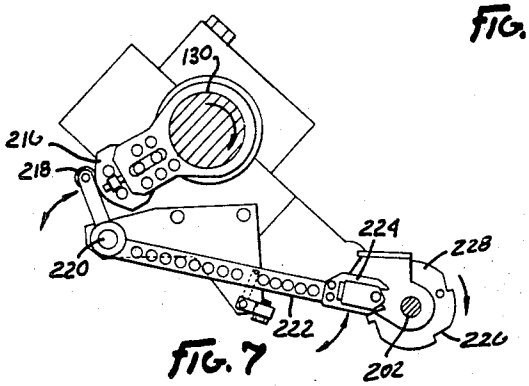


FIG. 7

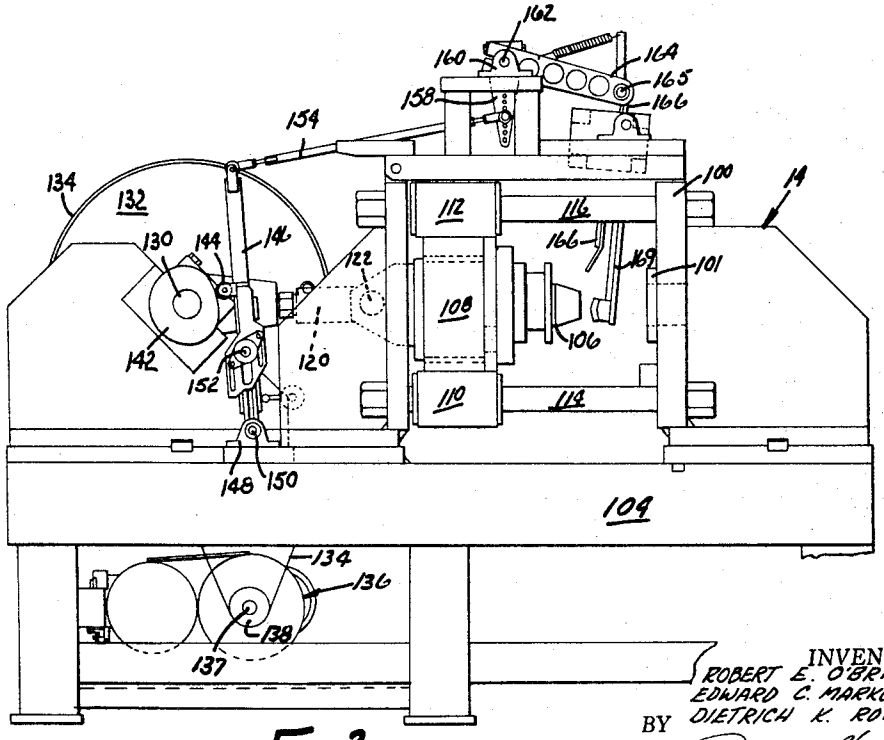


FIG. 2

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SHEET-FORMING AND POST-FORMING TRIM METHOD AND APPARATUS

Original Filed July 15, 1965 5 Sheets-Sheet 3

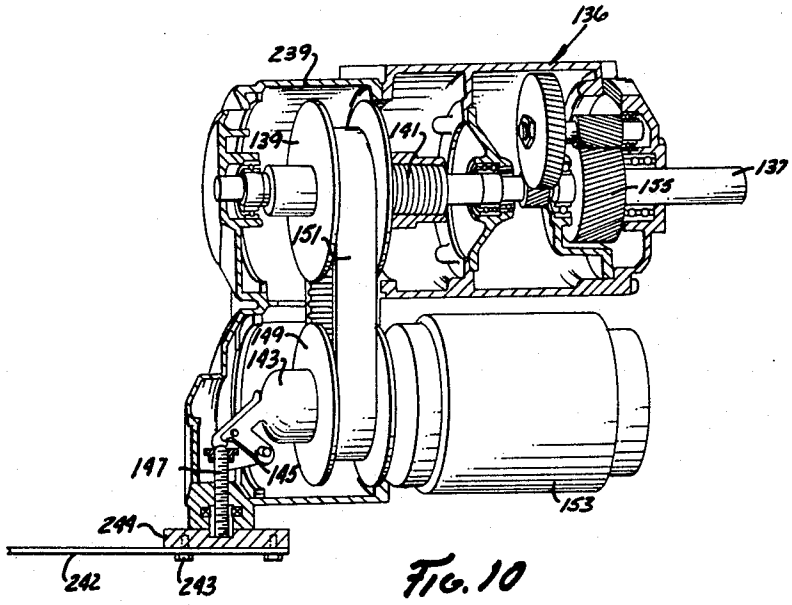


FIG. 10

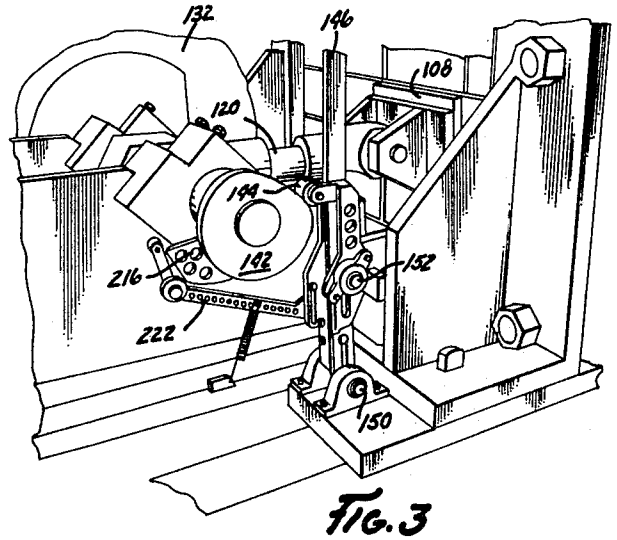


FIG. 3

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SHEET-FORMING AND POST-FORMING TRIM METHOD AND APPARATUS

Original Filed July 15, 1965 5 Sheets-Sheet 4

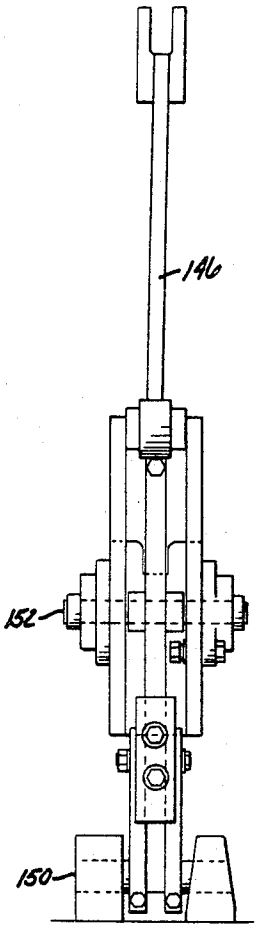


FIG. 5

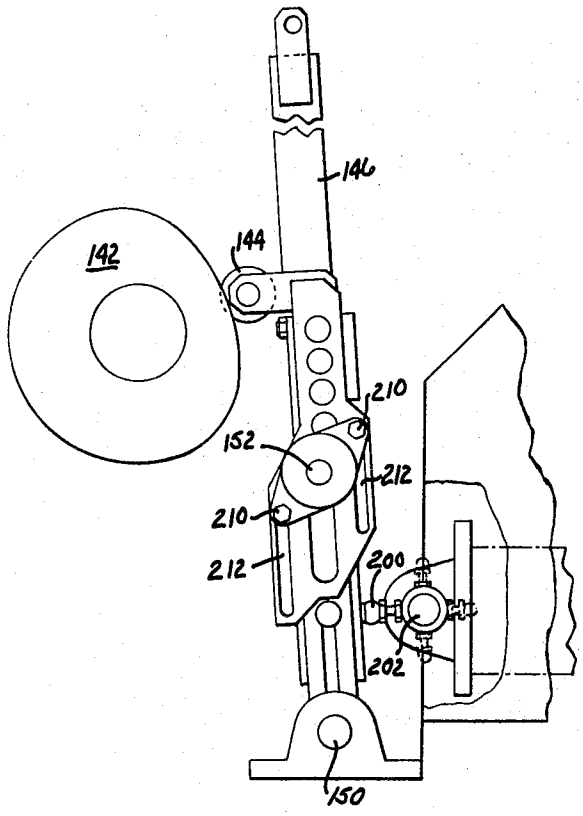


FIG. 4

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SHEET-FORMING AND POST-FORMING TRIM METHOD AND APPARATUS

Original Filed July 15, 1965 5 Sheets-Sheet 5

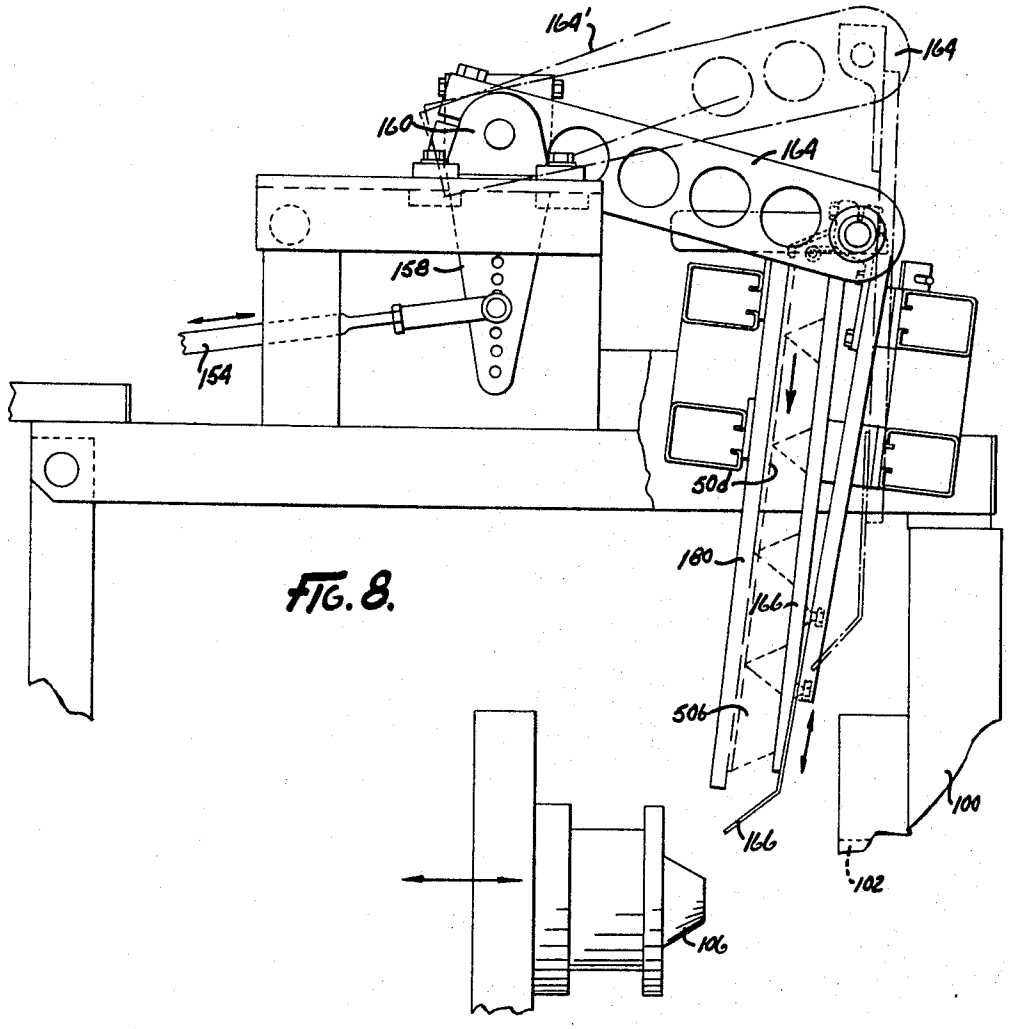


FIG. 8.

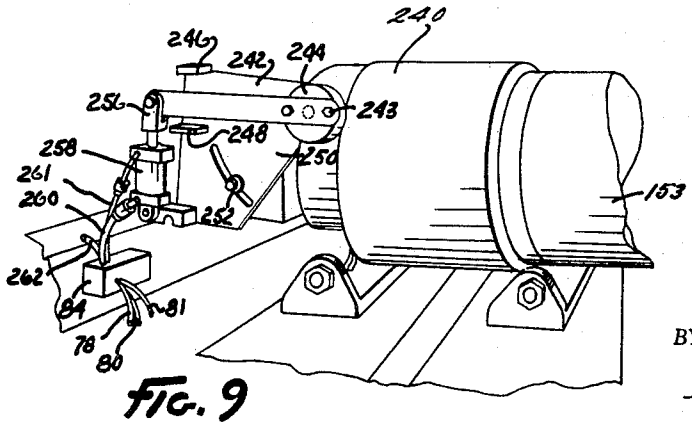


FIG. 9.

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United States Patent Office 3,388,625 Patented June 18, 1968

3,388,625

SHEET-FORMING AND POST-FORMING TRIM METHOD AND APPARATUS

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Original application July 15, 1965, Ser. No. 472,135, now Patent No. 3,329,995, dated July 11, 1967. Divided and this application May 4, 1967, Ser. No. 651,334

3 Claims. (Cl. 83—238)

ABSTRACT OF THE DISCLOSURE

A trim process for three dimensional articles is a web in repeat spaced patterns of a plurality of articles, having web advancing means causing repeat normal stroke advancement and a periodic different stroke advancement.

This application is a divisional application of the parent application entitled Sheet-Forming and Post-Forming Trim Method and Apparatus, filed July 15, 1965, Ser. No. 472,135, by Robert E. O'Brien, Edward C. Markowski, and Dietrich K. Roth.

This invention relates to apparatus for forming, advancing and severing three dimensional articles from a generally continuous web of plastically deformable material, and especially relates to web advancing and control means for and between forming and trim presses.

In apparatus for pressure forming three dimensional objects from a generally continuous web on a mass production basis, particularly a thermoplastic web, the articles are often formed into the web by physical and/or pneumatic pressure differential techniques in a reciprocating forming press, then subsequently severed from the web in a separate trim press. When forming the articles in the forming press, maximum efficiency is achieved by employing dies having a pattern of a plurality of like adjacent die faces to form a plurality of like articles with each press stroke. Sometimes the patterns, each composed of a plurality of articles, are spaced from each other in the web by an intermediate web portion. This spacing of patterns occurs in example, in webs that travel through a preheat oven prior to entering the forming press. This is because it has been found advisable to condition the portion of the web that is between the forming dies and the oven exit to prevent the web from distorting longitudinally through this portion. This can be done by blowing cold air on this section or by gripping it as explained more fully in copending patent application entitled Sheet Preheating and Forming Method and Apparatus, Ser. No. 474,034, filed July 22, 1965 and assigned to the assignee herein.

This spacing of the patterns of pluralities of articles creates a problem with web advancement in the trim press which must operate on each article. The advancing means normally advances the web uniform amounts equal to the width of each article. The last article in a pattern and the first article in the next pattern, however, are spaced a greater amount because of the web section between the patterns, as mentioned above.

Another difficulty occurring with web advancement from the forming press to the trim press is due to the fact that the web in the forming press is intermittently advanced each time an amount equal to the width of the pattern of several articles plus the space between the patterns, while the trim press is advanced only one article at a time. Yet, the web between the presses cannot get too taut or it will break, and cannot get too loose or its slack will drag on the floor, get tangled in the equipment, etc.

It is an object of this invention to provide web advancing and control apparatus for forming and trimming equipment of plastically deformable web material, achieving controlled correlated relationship between the article forming press and the article severing trim press.

Another object of this invention is to provide variable spaced web advancing means and correlated control means between the forming press and the trim press of pressure forming equipment for plastic web material, preventing excess web slackness and excess web tightness, and always automatically maintaining a controlled zone of tightness in the web between the presses, even though the presses tend to advance the web at different rates.

Another object of this invention is to provide a web advancing means for article trim press units, causing controlled feed of articles in repeat spaced patterns of pluralities of articles, to do so one article at a time, even when the spaces between the patterns are encountered. The advancing means in the trim press normally repeatedly shifts the web a width equal to one article, and uniquely automatically shifts the web an extra amount, periodically, to cover the space between the patterns of articles.

Another object of this invention is to provide an improved plastic article forming, advancing, and trimming apparatus for forming and severing three dimensional plastic articles from a generally continuous thermoplastic web.

These and several other objects of this invention will become apparent upon studying the following specification in conjunction with the drawings in which:

FIG. 1 is a perspective view of the complete forming, advancing and trim equipment for forming and severing three dimensional articles from a generally continuous plastically deformable web;

FIG. 2 is a side elevational view of the trim press forming part of the apparatus in FIG. 1;

FIG. 3 is an enlarged fragmentary perspective view of a portion of the trim press in FIG. 1, particularly showing a portion of the web advancing means for the trim press;

FIG. 4 is a side elevational view of the web advancing lever means in FIG. 3;

FIG. 5 is a rear elevational view of the apparatus in FIG. 4;

FIG. 6 is a top plan view of the apparatus in FIG. 4;

FIG. 7 is a sectional view of the apparatus in FIG. 6, taken on plane VII—VII;

FIG. 8 is a side elevational, enlarged view of the trim press advancing apparatus;

FIG. 9 is a perspective view of the variable speed power motor drive control means for the web advancing apparatus; and

FIG. 10 is a cutaway perspective view of the variable speed drive means in FIG. 9.

Referring now specifically to the drawings, particularly FIG. 1, the complete apparatus **10** there shown includes a forming press assembly **12**, a trim press assembly **14**, and a web sensor assembly **16** between the presses.

The forming press assembly **12** includes a pair of spaced upright pillars **20** and **22** with a cross beam **24** between the top ends thereof, and a support base **26** beneath the bottom ends thereof. The head **28** of the press has suspended therefrom a vertically reciprocable upper ram **30** with an upper die **32** mounted to the bottom thereof. This is operated by a toggle linkage **34** which may be actuated as by pressure cylinder means (not shown).

The lower die mounted to the bed **36** of the press may be fixed and stationary, or alternatively, vertically

reciprocable by a second toggle linkage (not shown in detail) operated by another fluid cylinder **38**. The apparatus for this structure includes web advancing means such as the pair of chain elements **40** on opposite sides of the press, extending from and advanceable through the preheat oven **42** to the outlet of the press adjacent guide surface **44**. Further details of the press may be seen in greater detail in copending application entitled Universal Forming Press, Ser. No. 474,132, filed July 22, 1965, now Patent No. 3,340,574, to the assignee herein.

The dies can use physical pressure and/or pneumatic pressure differential to form the articles into the thermoplastic web. The thermoplastic web is fed to the forming press from a roll **50** of generally continuous length, and rotatably supported on suitable stand means **52** to allow the web to be continuously pulled off, fed into and through the preheat oven **42** of selected length, and then between the dies of the reciprocable press, as advanced by moving chains **40**. These chains can be driven by a suitable motor. The preheat oven can be formed according to the teachings in copending application entitled sheet Preheating and Forming Method and Apparatus, Ser. No. 474,-034, filed July 22, 1965.

The plastic web **50***a* entering into forming press has formed into it a plurality of three dimenstonal articles **50***b*. Those are integrally pressed into its surface by the forming dies in selected spaced patterns, each pattern containing a plurality of like articles, as illustrated in FIG. 1. The web has a space **50***c* of webbing portion between the pattern. This space may be because of a conditioning treatment such as cooling air being blown onto this web portion between the preheat oven **42** and the forming press dies to prevent distortion of the last articles in the pattern, as explained more fully in copending application entitled Sheet Preheating and Forming Method and Apparatus, Ser. No. 474,035, filed July 22, 1965, and assigned to the assignee herein.

The web, with the articles formed into it but still intact, is conducted through a space **60** between the otulet side of the forming press and the arcuate guide **62** leading into the top of the trim press assembly **14**. Positioned in this space is the sensing assembly **16** of the web control, including an upper electrical switch web sensor unit **64** having a sensor finger **66** extending out over the web, and a lower electrical switch sensor unit **68** having a sensor finger **70** extending out below the web. Both of these sensor units are mounted on a suitable support stand **72** with a base **74**. Electrical leads **78** and **80** extend respectively from sensors **64** and **68**. These extend to the control unit shown in FIG. 9, and specifically the solenoid valve assembly **84**, as discussed more fully hereinatfer.

The guide assembly **62** has a generally arcuate, up and over support surface. It may be formed of a metal sheet **90** mounted on a suitable support stand **92**, or the equivalent such as conveyor rollers or the like. On the discharge, downwardly directed end of this guide is a pair of holding rollers **94** and **96** mounted to the support in positions to press the edges of the web **50***c* into downwardly directed relationship on its vertical path into the trim press.

This trim press, shown more specifically in FIG. 2, includes a fixed die plate **101** on support **100**, and having an article passage opening **102** therein, as well as a sharp peripheral edge around the opening. This plate is mounted fixedly to the framework **104** of the press, to be cooperative with the trim die **106** attached to the reciprocable ram **108**. This ram is mounted to reciprocate horizontally, by suspension on bearing sleeves **110** and **112** slidable on fixed guide rods **114** and **116**. The ram **108** is reciprocated horizontally toward and away from die plate **100** by a crank **120** pivotally attached at **122** to the rear end of the ram, and mounted on a conventional offset throw bearing of the crank shaft **130**. Its offset axis rotates about the shaft axis as is usual and as is illustrated by the axes shown at **121** and **123** in FIG. 6. The crank shaft is driven by a large fly wheel and pulley **132** which is rotated by V belts **134**. These belts are driven by a variable speed electrical drive assembly **136** having a pulley **138** on its output shaft **137**.

Mounted on the opposite end of crank shaft **130** from fly wheel **132** is web advancing means for the trim press, including a rotary cam **142** which makes one rotary revolution per each reciprocable revolution of the trim press. Abutting the periphery of this rotary cam is a cam follower wheel **144** rotatably mounted on the side of a vertically extending, arcuately rocking lever **146** that has two different pivot mounts. More specifically, the lower end of this lever is mounted to the pivotal journal **148** at lower pivot mount **150**. Closer to the cam and cam follower, i.e. between this pivot mount **150** and cam follower **144** is a second upper pivot mount **152** intermediate the ends of the lever. The lever has upper and lower parts overlapping at pivot **152**. The lever **146**, when appropriately treated, can pivot about either of those pivot mounts to have a different length stroke on link **154**. Normally, pivotal action of the lever with rotation of cam **142**, occurs about lowermost pivot **150**. The lever does not buckle at pivot **152**, under its regular oscillation, since, even though there is some bending force applied by cam **142** that tends to cause bending about pivot **152**, the backward force applied by link **154** at the upper end of the lever tends to counteract this and maintain the lever straight. The lever is made so that it can only buckle in one direction (clockwise as viewed in FIG. 2). This normal shifting of lever **146** causes its lever upper end to shift a predetermined distance in a slight arc, generally horizontally, to thereby shift link **154** a predetermined amount horizontally.

One end of link **154** is pivotally connected to the upper end of lever **146**, and the opposite end is pivotally connected to the downwardly depending rocking arm **158**. A shaft **162**, suspended in journal bearings **160**, has a keyed connection to arm **158**, and also is keyed to another cantilever type arm **164**. To the outer end of arm **164** is suspended pushing means, specifically fingers **166**. These pushing fingers, seen more specifically in FIG. 8, have a bent lower end to catch behind preformed articles **50***b* on web **50***d*, to push them downwardly as the arm reciprocates. These fingers straddle trim die **106** and die orifice **102** in plate **100** so as to not interfere with the die cutting operation. The fingers are pivotally mounted on their upper end to shift with the die and hold the article and web portion down until the web is gripped by pivotal holding elements **169** which also swing with die movement. Thus, as cam **142** (FIG. 2) rotates, lever **146** rocks back and forth on pivot **150** to shift link **154** back and forth, thereby rocking the depending arm **158** and tilting the cantilever arm **164** between its solid line position and its phantom line position illustrated in FIG. 8. This shifts the advancing pushing fingers **166** up and down between their solid line position and their phantom line position in FIG. 8, to thereby push one article down, and then back up while moving out and around the next article to catch in behind this next article. The web and articles are, therefore, pushed down the vertical guide **180** to place each article one at a time in front of die **106** so that, as the die reciprocates, the article is pushed into the die plate opening **102** and severed from the web. The articles are then collected on a suitable platform means **184** (FIG. 1) in horizontally stacked fashion or in suitable containers.

Because a definite space **50***c* exists between each pattern of a plurality of formed articles, the trim press advancing means must account for this. The advancing means normally advances the web with its integral articles an amount equal to the width of each article. In the web shown, the forming dies form three articles in each pattern of articles. Thus, the unit makes three normal strokes to advance the three articles in a pattern, one at a time. More specifically, the downward stroke of pusher

fingers **166** occurs with backward movement of lever **146** to the position on the small radius portion of cam **142** as shown in FIG. 2. The weight of cantilever arm **164** causes this downward pushing, to advance the web the width of one article. As cam **142** continues to rotate, lever **146** and rod **154** are pushed toward the web, to hoist pusher fingers **166**. Since the fingers are pivotally mounted on the upper end at **165** to the cantilevered end of arm **164**, they move out and around the three dimensional configuration of the next article, to catch behind the next article and push it downwardly in the next stroke. This occurs once with each revolution of the cam, and thus once with each revolution of the reciprocable trim die **106**. After three complete strokes of the trim die, and three shiftings of the web with lever **146** pivoting on its lowermost pivot **150** (FIG. 2), the fourth shift of this lever is of a different nature.

More specifically, lever **146** is caused on the fourth shift to pivot about its upper pivot mount **152** because of the contact of an abutment **200** (FIG. 4) with the back side of lever **146** opposite cam **142**. This abutment moves one quarter of a turn on its shaft **202** with each revolution of cam **142**. Thus, it moves through the four positions illustrated in FIG. 4, three of which are shown in phantom. Thus, during three of the pivotal strokes of lever **146**, the lever can pivot about its lower mount **150**, without interference from abutment **200**. At the fourth stroke, as cam **142** shifts from its small radius portions in contact with follower **144** to its large radius portions, the lever cannot shift about pivot **150** because of abutment **200**. This forces it to pivot about upper pivot **152**. Consequently, the movement of the upper end of the lever, and thus of link **154** attached thereto, is greater during this fourth stroke because of the leverage occurring with the closer location of pivot **152** to cam follower **144**. This causes fingers **166** to shift the web and articles a greater amount than the normal stroke, and in fact, an amount preset to equal the width of one article plus the width of space **50***d* between the two patterns of articles. This is preset by vertically adjusting the length of lever **146** with bolts **210** in slots **212** (FIG. 4).

The controlled rotation of abutment **200** (FIG. 4) is achieved by the ratchet drive assembly shown in FIGS. 6 and 7. More specifically, mounted on crank shaft **130** is a radially projecting rotating cam **216** which rotates one revolution for each revolution of the crank shaft. This cam abuts and shifts a cam follower **218** once each revolution, to pivot it on its pivot shafts **220**. This pivoting also causes arcuate movement of radial leg **222** keyed to shaft **220**, to thereby hoist the forked end **224** of this shaft once each revolution. This fork end fits alternately within each of the four notches **226** on rotating ratchet wheel **228** keyed to shaft **202** that mounts the radially projecting abutment **200**.

This shaft **202** is mounted rotatably in a pair of spaced bearing journals **232** and **234**. Thus, each revolution of crank shaft **130** causes pivoting of arm **222** for shifting ratchet wheel **228** and thus shaft **202** 90° to move abutment **202** through the four positions illustrated in FIG. 4. Consequently, every fourth revolution of the apparatus causes a large shift of the web and article to cause arm **164**, for example, to move to the second phantom line position at **164'** (FIG. 8), rather than the lower phantom line position.

All of these cam and crank mechanisms on the trim press are driven, therefore, from the belt and pulley assembly **138**, **134** and **132**. These are driven by a variable speed drive means **136** shown in FIGS. 2, 9 and 10. This variable speed drive means operates according to a well-known variable pulley principle. A first, variable diameter, expandable pulley **139** is biased together by coil spring **141**. A second, spaced, expandable variable diameter pulley **149** is mechanically actuated by a hub **143** and a linkage **145** attached thereto and to a threaded rotatable stud **147**. A wide drive belt **151** extends around the pulleys. Pulley **149** is driven by an electrical motor **153**. Pulley **139** drives the output shaft **137** through speed reduction gears **155**.

Variable regulation of the output of the assembly is achieved by rotation of stud **147** to change the size of pulley **149** in housing **240**, and thereby force the corresponding change in pulley **139** in housing **239**. In this assembly, a hub **244** is affixed to the end of stud **147**. A radially extending lever **242** is attached to this hub by bolts **243**. Lever **242** can shift in the range between an upper stop **246** and a lower stop **248**. These stops are mounted on a fixed plate **250** which is initially angularly adjustable with bolt and slot connection **252**. On the opposite end of lever **242** from hub **244** is a pivotal connection to the extended cylinder shaft **256** of fluid actuated cylinder **258**. This fluid actuated cylinder is supplied by pressurized air or fluid through lines **260** and **261** from solenoid valve **84** that communicates through a line **262** to a pressurized supply (not shown). The solenoid valve, as stated previously, is controlled through electrical leads **78**, **80** and **81** which connect this unit electrically to web sensor switches **64** and **68** (FIG. 1) and to a power supply. This entire assembly controls the speed of operation of the trim press in relation to the condition of the web between the two presses. If the web becomes excessively slack and contacts lower sensor finger **70** of electrical limit switch sensor **68**, the switch is actuated to complete a circuit through solenoid valve **84**, shifting it in one direction to supply fluid to cylinder **258**. The cylinder shifts lever **242**, which varies the spacing of the pulleys, causing a change of the drive belt relationship to speed up the drive output to the several crank and cam drives for the trim press, with respect to the forming press. This causes the trim press to operate faster, thereby drawing the slack out of the web.

If, on the other hand, the web becomes too taut and contacts upper sensor finger **66** of electrical switch **64**, this limit switch closes a circuit which shifts solenoid valve **84** in the opposite direction, to retract the cylinder, causing lever **242** to retract and slow down the drive relationship. Thus, the trim press operates more slowly and causes greater slack to occur in the web. The unit is thus automatically controlled to maintain a certain range of web slackness between the two presses.

It is conceivable that this control system could control the forming press speed rather than the speed of the trim press, but usually it is desirable to maintain a constant output from the forming press to prevent over heating or under heating of the web prior to forming.

With this apparatus, automatically controlled synchronization always occurs between the two presses, even though the forming press shifts the web an amount equal to a pattern of a plurality of articles (here three), plus the spacing **50***c* therebetween, and while the trim press only shifts the articles one at a time, except for the larger shift to encompass one article and the space therebetween as it moves between two patterns of articles.

Certain additional advantages may occur to those in the art upon studying the foregoing disclosure and description. It is also conceivable that certain minor variations in structure could be made within the concept presented. Hence, the invention is intended to be limited only by the scope of the appended claims and the reasonably equivalent structures to those defined therein.

We claim:

1. A trim press apparatus for performing a trim operation on three dimensional articles formed into a generally continuous web in repeat spaced patterns, each of a plurality of articles, comprising: reciprocable trim die means; web advancing means for intermittently advancing successive web portions and articles in said portions into operative relationship with said die means; said advancing means including a reciprocable pushing pivotal lever means having a predetermined repeat stroke length for advancing the web an amount equal to the width of each

article in a pattern; cam means operably associated with said lever means, spaced from its pivot, to cause said repeat stroke; and means causing a periodic stroke length greater than said normal stroke length for advancing the web an amount equal to the width of an article plus the spacing between patterns; said last mentioned means comprising a second pivot for said lever means, and intermittent actuating means to cause said cam to pivot said lever means about said second pivot to cause said greater stroke length.

2. A trim press for performing a trim operation on each three dimensional article formed into a generally continuous web in repeat spaced patterns, with a plurality of articles in each pattern, comprising: a support frame; reciprocal trim die means on said frame; a rotating, power driven fly wheel means, crank means operably connected therewith and with said die means for reciprocation thereof, and power drive means therefor; a rotating cam means operably connected to said power drive means; reciprocable web advancing pusher means adjacent said die means to advance successive articles and surrounding web portions to said die means; lever means operably connected to said pusher means, operably engaged by said cam means, and having two spaced pivot mounts at different spacings from said cam means; said lever means normally shifting about one of said pivot mounts to advance said pusher means a predetermined normal amount equal to the width of an article; lever abutment means adapted to abut said lever between said mounts when activated; means operably associated with said advancing means to intermittently activate said abutment means after a repeat number of pusher strokes, causing said lever means to shift about said second pivot mount, thereby causing said pusher means to shift the web a predetermined different amount over the spacing between article patterns in the web.

3. A trim press for performing a trim operation on each three dimensional article formed into a generally continuous web in repeat spaced patterns, with a plurality of articles in each pattern, comprising: a support frame; reciprocal trim die means on said frame; crank means operably connected with said die means for reciprocation thereof, and power drive means therefor; a rotating cam means operably connected to said power drive means; reciprocable web advancing means adjacent said die means to advance successive articles and surrounding web portions to said die means; oscillating lever means operably engaged by said cam means, and having two spaced pivot mounts at different spacings from said cam means; oscillatory link means connecting said lever means and said advancing means; said lever means normally shifting about one of said pivot mounts to shift said link means and advancing means a predetermined normal amount; lever abutment means adapted to abut said lever between said mounts when activated; shifting means for said abutment means; means operably associating said shifting means with said cam means to intermittently activate said abutment means after a repeat number of strokes of said advancing means, causing said lever means to shift about said second pivot mount, thereby causing said pusher means to shift the web a predetermined different amount over the spacing between article patterns in the web.

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JAMES M. MEISTER, *Primary Examiner.*