Nov. 16, 1965 J. M. VOSS 3,217,397

CAP FORMING SYSTEM AND METHOD

Filed June 15, 1962 8 Sheets-Sheet 1

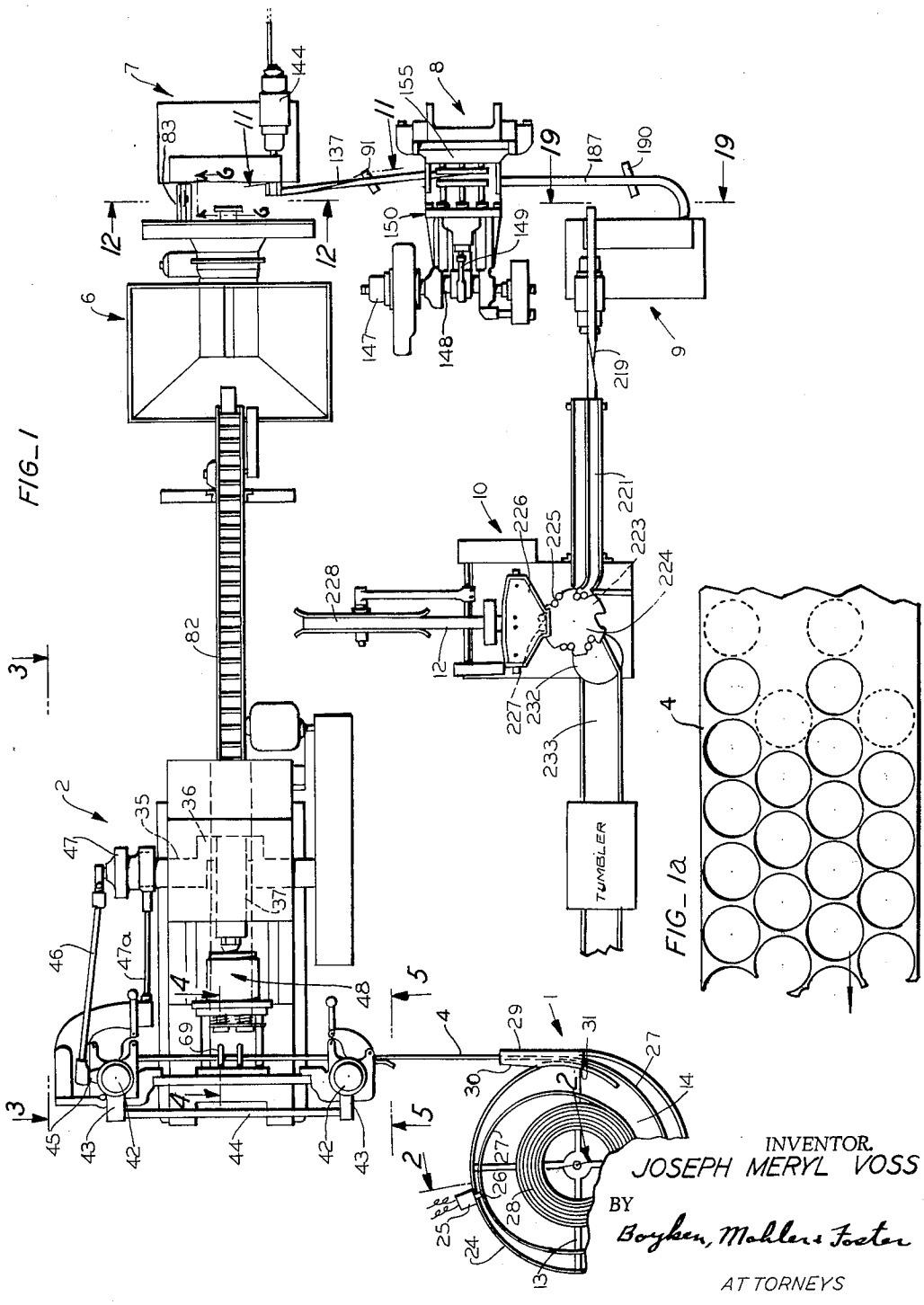


FIG_1

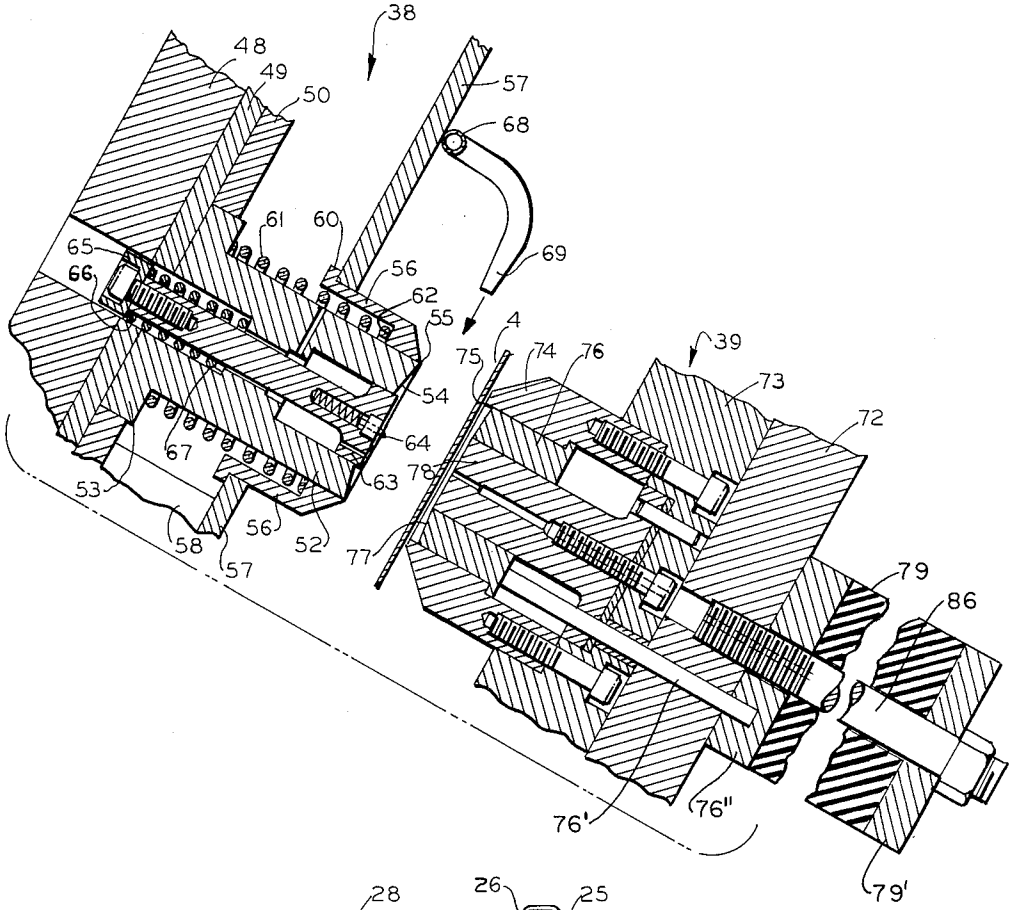
FIG_12

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CAP FORMING SYSTEM AND METHOD

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FIG_4



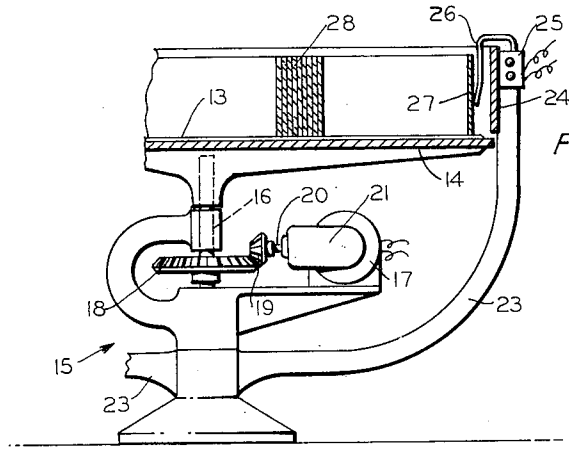


FIG_2

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Nov. 16, 1965 J. M. VOSS 3,217,397

CAP FORMING SYSTEM AND METHOD

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FIG_3

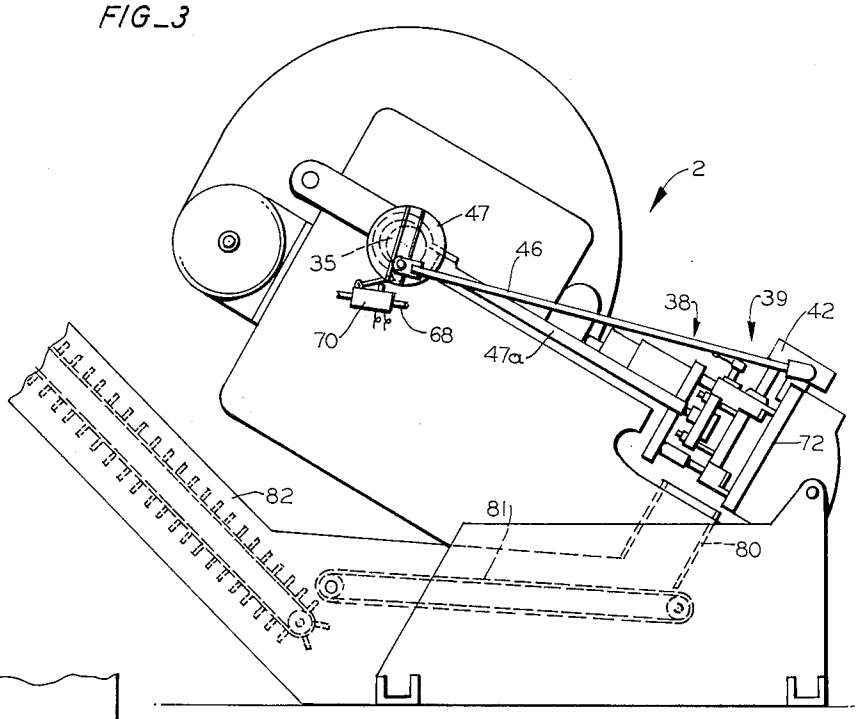


FIG_9

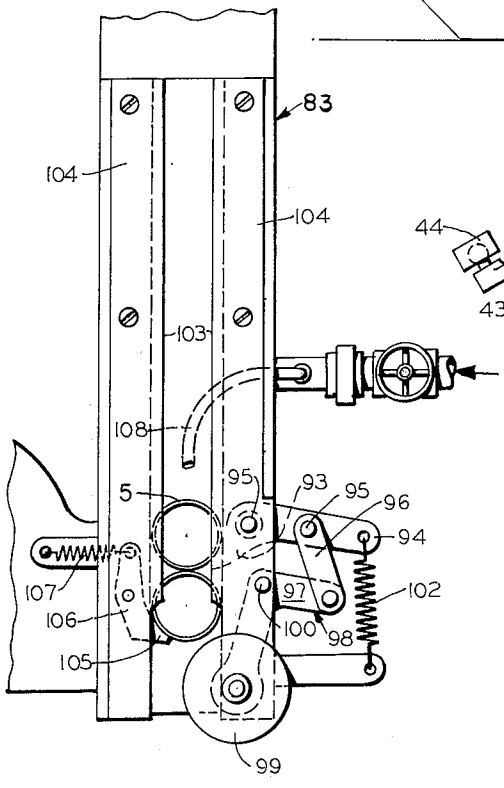
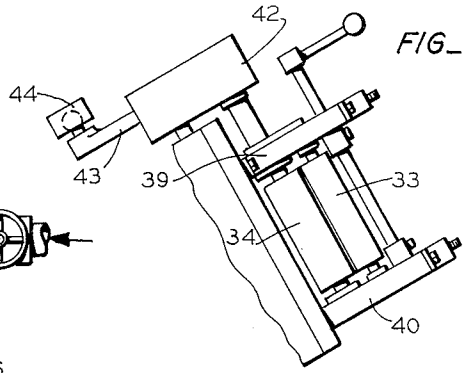


FIG_5



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CAP FORMING SYSTEM AND METHOD

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FIG_6

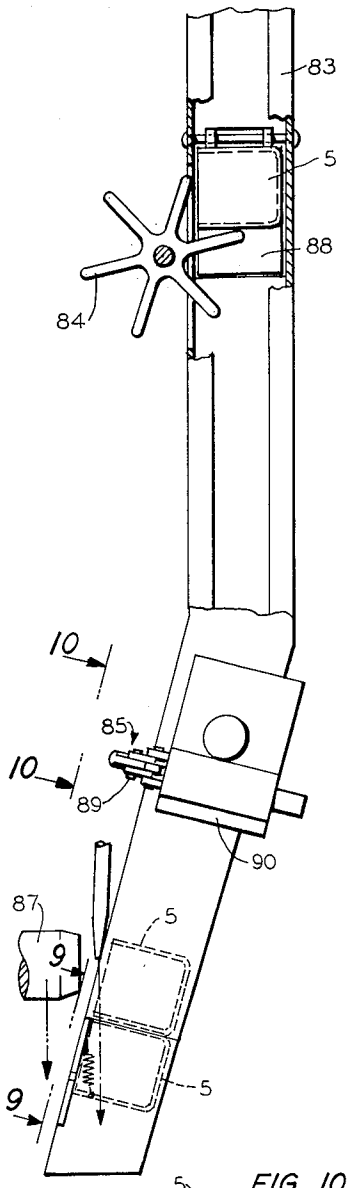


FIG_7

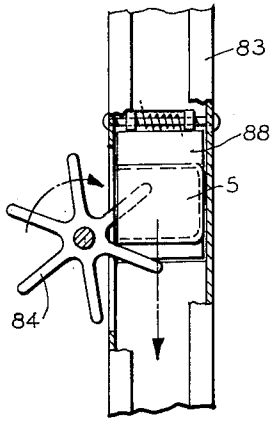


FIG_8

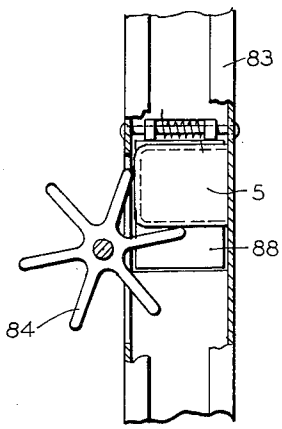


FIG_11

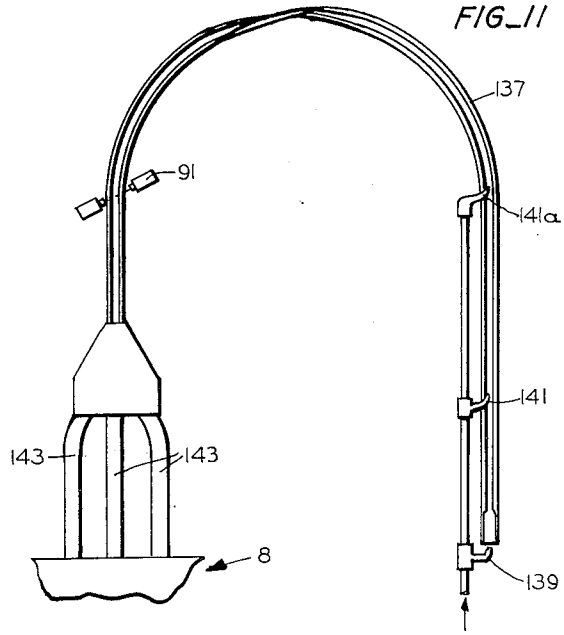
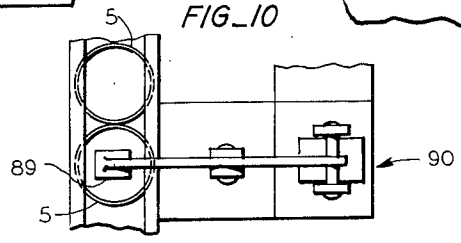


FIG_10

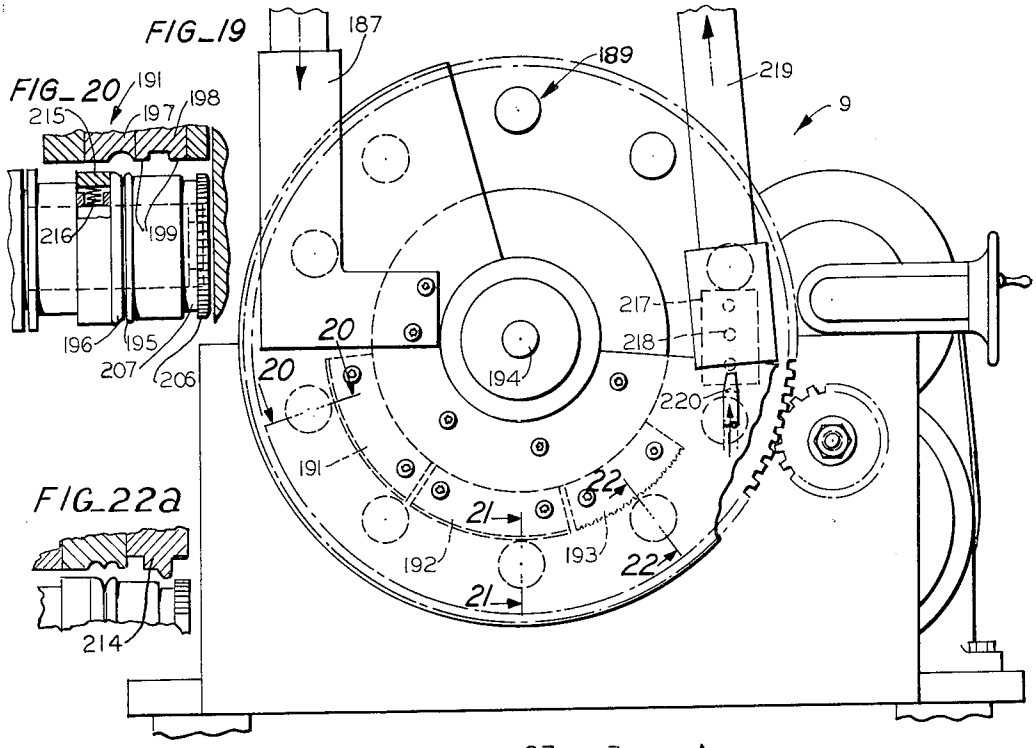


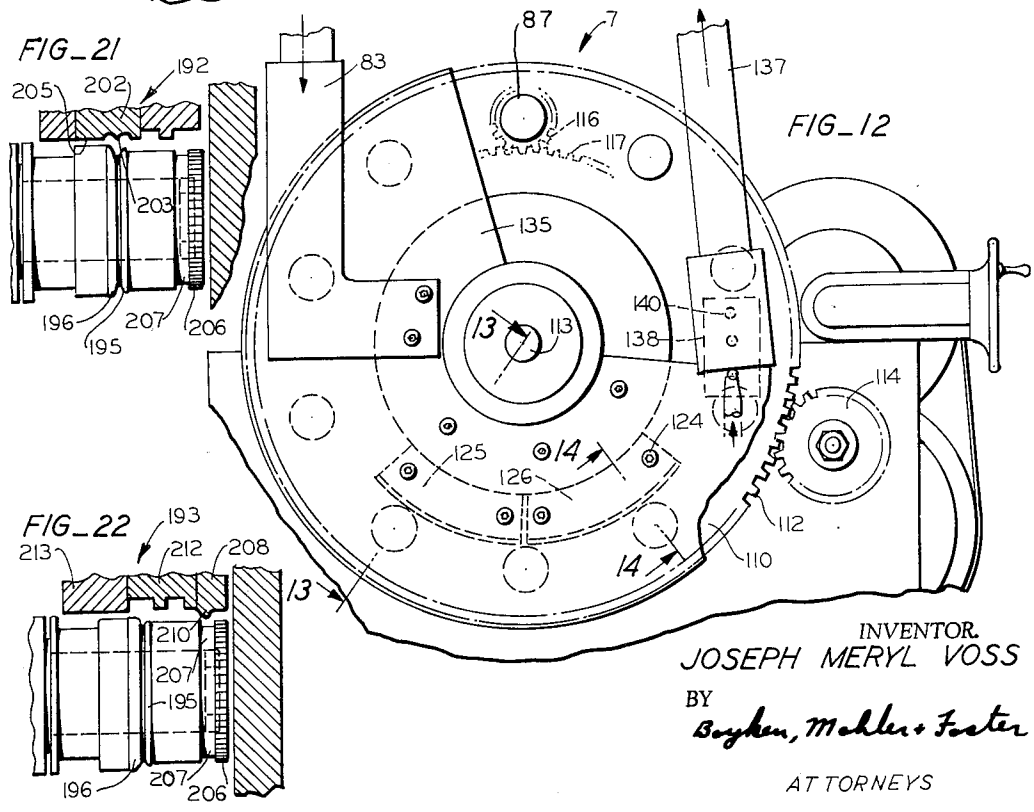
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CAP FORMING SYSTEM AND METHOD

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CAP FORMING SYSTEM AND METHOD

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FIG_13

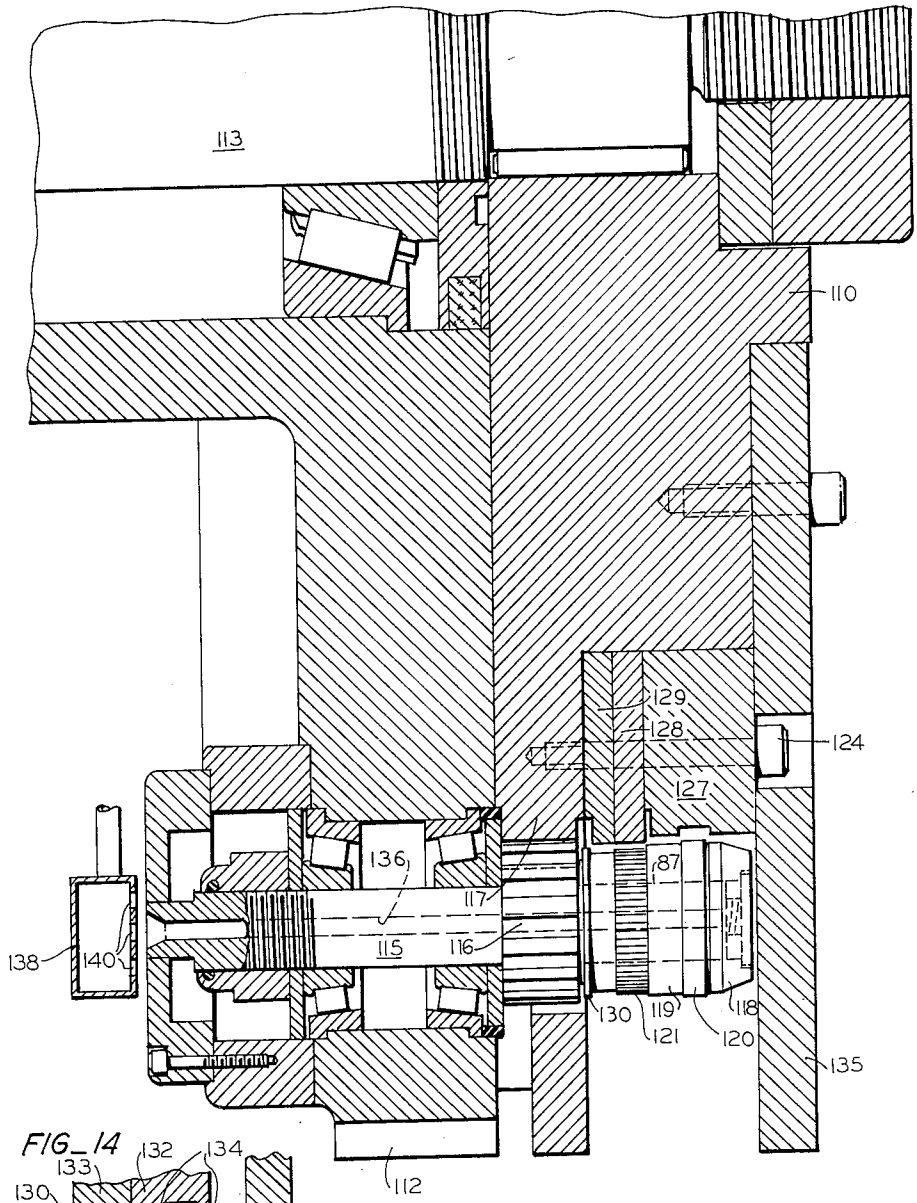
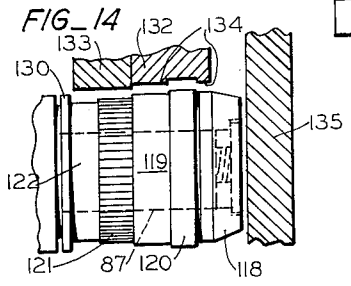


FIG_14



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CAP FORMING SYSTEM AND METHOD

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FIG_15

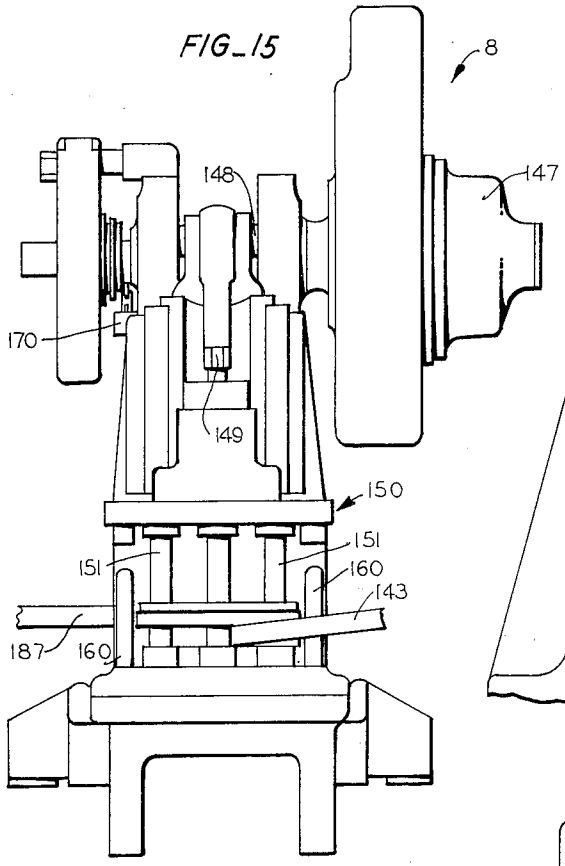


FIG_16

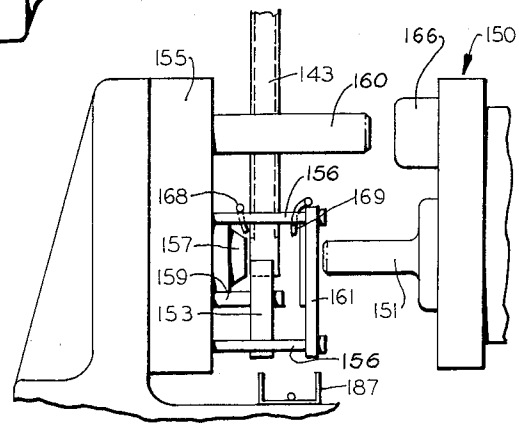


FIG_17

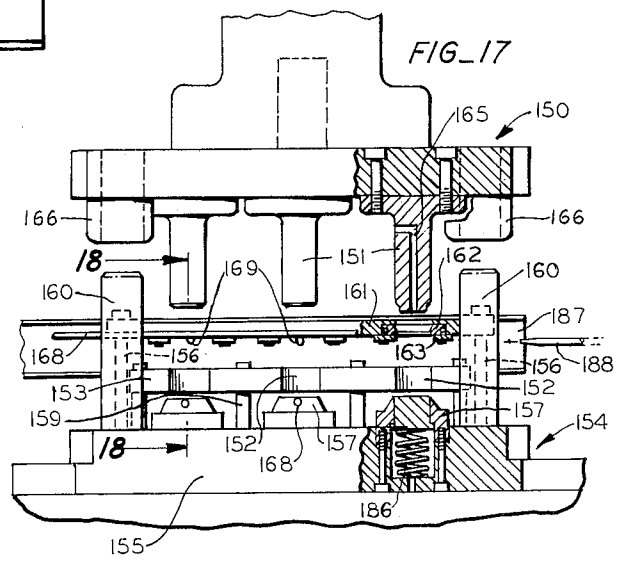
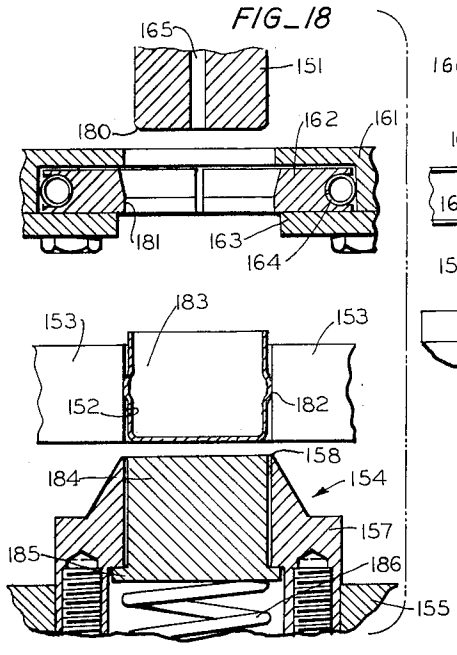


FIG_18



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CAP FORMING SYSTEM AND METHOD

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FIG_23

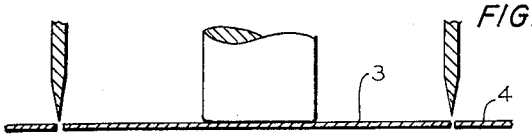


FIG_24

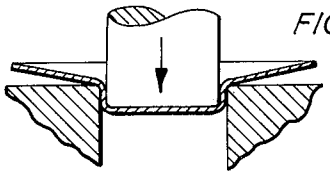


FIG_28

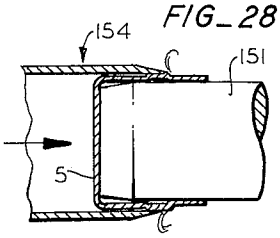


FIG_25

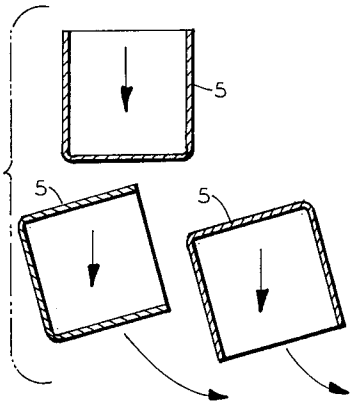


FIG_26

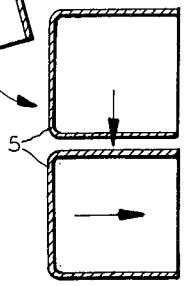


FIG_29

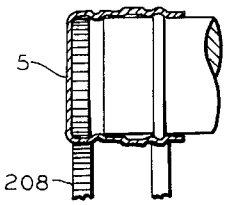


FIG_27

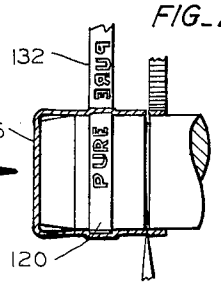


FIG_30

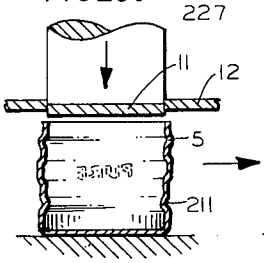


FIG_31

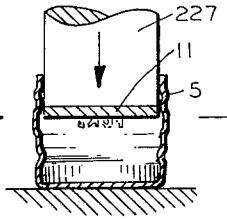


FIG_32

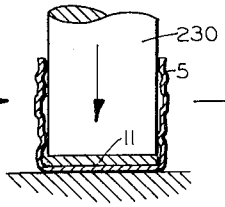
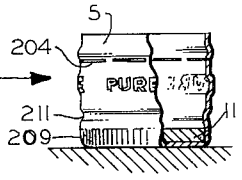


FIG_33



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United States Patent Office 3,217,397 Patented Nov. 16, 1965

3,217,397

CAP FORMING SYSTEM AND METHOD

Joseph Meryl Voss, San Francisco, Calif., assignor to Chemetron Corporation, Chicago, Ill., a corporation of Delaware

Filed June 15, 1962, Ser. No. 202,904
16 Claims. (Cl. 29—430)

This invention relates to the production of closure caps from sheet material, and has for one of its objects the provision of a method or process in which the formation of uniformly accurate caps having identifying symbols thereon, and other separate different physical characteristics for different functional purposes, is substantially continuous from an initial step in which the material for the caps is continuously stamped from a coil of material, until each cap is in a form for final securement on the container to be closed thereby.

Another object of the invention is the provision of a combination of separate means in a closure cap forming system for more expeditiously forming closure caps than heretofore, and which means performs a continuous sequence of separate steps that are correlated for accomplishing the end result of a cap having identifying indicia thereon, and other structure to facilitate manual manipulation of each cap for application to and removal from a container.

Closure caps of metal are normally positioned over the externally threaded necks of bottles or the like, and the skirts of said caps are forced against said threads to shape threads on said skirts that are complementary to the threads on said necks.

The upper end of the skirt of each cap adjacent to the top of the cap may be knurled or roughened to facilitate manual gripping of each cap for threadably removing it from the bottle, and for threadably securing such cap onto the neck.

A sealing disc or liner is positioned within each cap against the lower surface of the top, which liner may be frictionally held at its edges above and inwardly projecting ridges that defines the juncture between the knurled portion of the skirt of the cap and the portion of the skirt therebelow.

The caps may be formed to provide embossed letters or symbols on their skirt portions, or they may be formed from printed coil stock.

In forming caps provided with embossed letters or symbols, initially the outer surface of each cap which is embossed has a lacquer, enamel or other outer coating that may be of a color different from that of the metal of the cap, although the difference in the appearance of the uncoated metal and a coating of lacquer, enamel, or the like, is readily apparent.

In order to give the embossed letters or indicia a richer and more distinctive appearance, the outer coating of lacquer, enamel, or the like on the outermost surfaces of the embossed letters or indicia is removed or shaved to the metal and even a very thin skin of the metal itself may be removed to insure leaving a bright metal surface that conforms to the embossed letters or indicia.

When the caps are formed from printed coil stock they obviously need not be subjected to the embossing operation and the associated shaving operation to remove lacquer, enamel or the like, and a thin skin of the metal from the outermost surfaces of the embossed letters or indicia. However, when the caps are made from printed coil stock the blanking and forming operations must be precisely correlated with the printed matter on the coil stock so that the printing appears in the proper location on the finished caps. Such correlation can be achieved by a suitable photosensitive indexing device for scanning

the printed coil stock and ensuring that the blanking and forming operations are appropriately coordinated with the location of the printed matter on the coil stock.

The closure caps formed by the system are generally of the roll-on type in which the threads are formed by rolling and shaping the cap shell or skirt against the container threads and further may be of the pilfer-proof type, that is, of the type which is serrated about its lower edge portion to provide a short shell section or band connected to the main cap shell by a series of bridges. This marginal band portion is rolled under a lower bead or locking ring on the container and breaks away from the main cap shell but remains on the container when the cap is twisted for removal. Thus there is clear evidence that the cap has been loosened or removed and that some of the contents of the bottle may have been consumed or pilfered. Purchasers of bottled goods having pilfer-proof caps quickly learn to accept only bottles having their caps intact and tightly screwed onto the bottles.

If the roll-on closure caps are not of the pilfer-proof type the serrations about the lower edge of the cap are omitted and the extremity of the skirt of the cap has a rolled edge or bead. Such caps are used, for example, as closures for catsup bottles.

Heretofore caps of similar structure have been produced, but in the present method the steps in the production of the caps from a coil of sheet stock material to the finished caps is substantially continuous and automatic, and the caps are of uniform high quality. Also the method employed includes forming the caps from a metal strip in a roll in a manner that reduces scrap losses to a minimum and increases the efficiency of the entire system.

Other objects and advantages will appear in the description and in the drawings.

In the drawings, FIG. 1 is a semidiagrammatic top plan view of the different means connected in the cap forming system for making caps.

FIG. 2 is a fragmentary sectional view taken along line 2—2 of FIG. 1 through part of the feed device for a coil or roll of the strip of metal stock from which the strip is fed to the draw press.

FIG. 1*a* is an enlarged fragmentary plan view showing a portion of the strip that has been punched out by the punch and draw press and a portion to be punched out and drawn.

FIG. 3 is a side elevational view of the punch and draw press, as seen from line 3—3 of FIG. 1.

FIG. 4 is an enlarged, fragmentary sectional view taken along line 4—4 of FIG. 1.

FIG. 5 is an enlarged fragmentary view taken along line 5—5 of FIG. 1.

FIG. 6 is an enlarged elevational view, partly in cross section, taken along line 6—6 of FIG. 1.

FIGS. 7, 8 are fragmentary part sectional, part elevational views of a portion of FIG. 6 in different positions.

FIG. 9 is a fragmentary elevational view on line 9—9 of FIG. 6 showing the spindle actuated cap releasing means.

FIG. 10 is a fragmentary elevational view of an electrically actuated stop means on the conveyor, as seen from line 10—10 of FIG. 6.

FIG. 11 is a portion of the conveyor means for the caps as seen from line 11—11 of FIG. 1, and which view shows the means for actuating the stopping of the embossing machine before the system following the embossing machine should become choked with caps.

FIG. 12 is a front elevational view of the embossing and trimming machine, partly broken away, and generally as seen from line 12—12 of FIG. 1.

FIG. 13 is an enlarged, sectional view taken through the trimming die and spindle, substantially along line 13—13 of FIG. 12.

FIG. 14 is an enlarged fragmentary sectional view taken along line **14**—**14** of FIG. 12.

FIG. 15 is an enlarged top plan view of the shaving machine for removing or shaving lacquer, paint or the like from the embossing on the caps, including the skin of the metal.

FIG. 16 is a fragmentary side elevational view of a portion of the shaving machine.

FIG. 17 is a fragmentary part sectional and part top plan view of the portion of the shaving machine adapted to remove the lacquer or paint.

FIG. 18 is a fragmentary enlarged cross sectional view taken substantially along line **18**—**18** of FIG. 17.

FIG. 19 is a front elevational view of the knurling, rolling and serrating machine, as seen from line **19**—**19** of FIG. 1.

FIG. 20 is an enlarged fragmentary cross sectional view taken along line **20**—**20** of FIG. 19.

FIG. 21 is an enlarged fragmentary cross sectional view taken along line **21**—**21** of FIG. 19.

FIG. 22 is an enlarged, fragmentary cross sectional view taken along line **22**—**22** of FIG. 19.

FIG. 22*a* is a modification of the structure shown in FIGS. 21, 22.

FIGS. 23 to 33 illustrate the successive steps of the method of forming the caps, the cap being shown in cross section in each of the drawings from FIGS. 25 to 33, and the blank from which the cap is formed being shown in cross section in FIG. 23, while FIG. 24 illustrates the cap being drawn, the partially formed cap being shown in cross section.

The system and method generally

Referring to the two sheets of drawings on which FIG. 1 and FIGS. 23 to 33 are shown, an exemplary system for carrying out the method or process is shown in FIG. 1, while an exemplary method of forming and completing the caps is schematically shown in FIGS. 23 to 33. The system illustrated in FIG. 1 and the method shown in FIGS. 23–33 are adapted to produce roll-on caps of the embossed pilfer-proof type. However, it will be recognized by those skilled in the art that the system of FIG. 1 and the method of FIGS. 23–33 can be readily modified to produce pilfer-proof caps from printed coil stock merely by omitting the embossing and shaving operations, and providing suitable means such as a photo-sensitive device to correlate the blanking and forming operations with the printed matter on the coil stock. Also, roll-on caps without the pilfer-proof feature can be produced with the system illustrated in FIG. 1 and the method of FIGS. 23–33 merely by omitting the serrating operation and by rolling the lower edge of the cap skirt in the known manner.

The numeral **1** in FIG. 1 generally designates a material feeding machine **1**, which machine supports a roll or coil of pliable sheet material, such as aluminum or aluminum alloy that is fed to the punch and draw press, generally designated **2**. The side of the material that will ultimately be the outside of the cap is preferably covered with lacquer, enamel or other coating.

The punch and draw press stamps or cuts circular discs **3** (FIG. 23) from the strip stock **4** and draws each disc (FIG. 24) generally to cap form.

Cap blanks **5** (FIG. 25) formed by the punch and draw press stage are conveyed to an orienting device or station **6** (FIG. 1) in indiscriminately arranged relation (FIG. 25) in which latter device they are oriented so that they emerge in single file with their open ends facing the same direction laterally of the file or row (FIG. 26).

After the caps are so oriented at the orienting station **6**, said caps are conveyed to a cap trimming and embossing station and device generally designated **7** where the skirt on each cap may be embossed with indicia and evenly trimmed along its free edge (FIG. 27). Preferably the trimming precedes the embossing operation.

From the trimming and embossing machine the caps are successively conducted to a shaving machine **8** where a cutter cleans, abrades or shaves the outer lacquer or other coating off the outermost surfaces of the embossed letters or symbols (FIG. 28).

Following the shaving or coat removing step, the caps are conducted, in single file, to a bead forming, serrating and knurling station **9**. This device also forms a radially inwardly projecting ridge in the cap skirt adjacent to the knurling to act as a retainer for a liner to be held thereby adjacent to the closed end of the cap.

From the knurling and serrating apparatus **9**, the caps are conducted to a cap liner station generally designated **10** (FIG. 1) where sealing discs **11** are stamped from a coil or strip stock **12** of liner material (such as vinyl coated paper or paperboard) at a point over the open sides of the caps **5** (FIG. 30). These discs are successively pressed into the caps and against their tops (which are lowermost in machine **10**, FIGS. 31, 32), and when this is finished, the cap is completed (FIG. 33), unless an optional tumbling step is desired to remove any residual loose metal particles (such tumbler is indicated in FIG. 1).

While the punch and draw press **2**, the shaver **8** and the liner **10** are intermittently actuated, the movement of the caps from the punch and draw press to and past the liner **10** to the point where the finished caps are packaged is continuous and is substantially automatic.

The strip feed machine 1

Heretofore it has been customary to feed separate straight strips of predetermined relatively short length to a punch and draw press, with the result of substantial waste in material, since the strip feeding rollers at the opposite sides of the punch and die portion are necessarily spaced from the latter causing substantial end losses on each separate piece.

Whether the straight strips heretofore have been manually or automatically fed to the press from a magazine stack, there has also been a substantial time loss due to the loss in punching time attributable to the movement of unpunched leading and trailing ends of each strip together with the end material losses.

FIG. 1*a* illustrates a portion of continuous coil strip stock **4** that has been punched out to form caps, there being illustrated four punches and dies in horizontally aligned pairs and in staggered relation in the punch and draw press, as will later be described in greater detail. The broken lines **12** illustrate the next group of four caps to be punched out and drawn, while the full lines indicate the openings formed by a plurality of previous punching operations. The direction of movement of the deformable feed stock is indicated by the arrow.

By the use of the coil or roll, a continuous strip of metal is fed to the punch and draw press thereby reducing the amount of end scrap to the minimum, and also materially increasing the capacity of the punch and draw press.

The problems of unwinding the strip from a heavy roll thereof and feeding it to the punch and draw press free from tension on the strip have been overcome by supporting the roll horizontally on spaced, upwardly projecting ridges **13** (FIG. 1) that extend radially outwardly from the center of a circular horizontal table **14**.

The table **14** is carried on a pedestal, generally designated **15** and is centrally connected with a shaft **16** that, in turn, is supported by said pedestal for rotation. Any power means, such as a motor **17** may be suitably connected with shaft **16** for rotating the latter in a counterclockwise direction, as viewed in FIG. 1. In FIG. 2 a gear **18** secured on shaft **16** is in mesh with a gear **19** that, in turn, is on a shaft **20** that is driven by motor **17** through suitable reduction gears in a gear box **21**.

Carried by pedestal **15** are plurality of arm **23** that carry a stationary, annular cylindrical wall **24**, which wall is above the table **14**, and concentric therewith. The

lower edge of said wall 24 is adjacent to the outer peripheral edge of the table.

Carried by pedestal 15 are a plurality of arms 23 that is an electrical switch 25 (FIG. 2) that is in the electrical circuit with motor 17, and a switch arm 26 extends over the wall 24 (FIG. 2) and downwardly adjacent to the inner side of the latter, and is adapted to be moved toward the wall 24 when the outer coil 27 of the roll 28 of the sheet material strip 4 is driven outwardly due to rotation of the table 14 counterclockwise at a rate of speed that is faster than the rate at which the strip 4 is moved through the punch press 2. The roll 28 is supported on the ribs 13 hence has little frictional resistance to outward sliding of the outer coil 27 of roll 28 toward the wall 24 and, of course, the coil 27 must be supported on the table 14 for unwinding in a counterclockwise direction.

Switch arm 26 (FIG. 2) is spring urged in a direction toward the center of the table, and when the outer coil is drawn away from the switch arm due to withdrawal from the strip feed machine by the punch press 2, the circuit to the motor is closed to cause the motor to drive the table for again urging the outer coil against the switch arm to move said arm outwardly and to thereby actuate the switch for opening the circuit to the motor.

The position of the switch 25 is just beyond, in a counterclockwise direction, the outlet in wall 24 for the strip 4, hence substantially a complete slack coil of the strip 4 is maintained on table 14 around the roll 28, thereby relieving the drive at the punch press from moving roll 28. Inasmuch as roll 28 normally may weigh upward of 400 lbs., the structure and manner of operation of the coil strip stock feed device is important.

The outlet for the strip 4 may comprise a gap in the wall 24, and a pair of spaced guide plates, one wall 29 of which may be an extension of wall 24 extending tangentially therefrom, and the other wall 30 may be substantially parallel to wall 29 and then extend through the gap in wall 24 and into the area within the latter and over the table so as to guide the strip 4 from a point within wall 24 to the gap in the latter and to between walls 29 and 30 outside of wall 24.

This extension of the wall 30 is indicated at 31 in FIG. 1 and functions to insure the proper expansion of the outer coil 27 as the coil 28 is unwound, irrespective of nicks or edge deformities along the lower edge of strip 4 that may tend to prevent such expansion through engagement with the ribs 13 on the table.

The walls 29 and 30 outside the cylindrical wall 24 project toward the feed rollers 33, 34 (FIG. 5) at one side of the cutting and draw elements of the press 2.

Cutting and draw press

FIGS. 1 and 3 show, in general, the cutting and draw press 2, which will hereinafter be called the "press."

The general construction of the press is not new. It includes the usual main crank shaft 35 (FIG. 1) having crank 36 that, in turn, is connected by a rod 37 with the punch assembly generally designated 38 (FIG. 4) for reciprocating the latter to and from the stationary die assembly that is generally designated 39.

The strip 4 leaves the strip feed machine in a vertical position (transversely of its length) and extends between the pair of infeed rollers 33, 34 at the infeed side of press 2, which rollers, as seen in FIG. 5, are inclined slightly relative to vertical. A corresponding pair of outfeed rollers are at the outfeed side of the press, and have the same degree of inclination as the infeed rollers. The strip 4 extends between the infeed and outfeed pair of rollers and across the die assembly. These pairs of rollers 33, 34 are in gripping relation to the strip 4 and drive the strip across the die assembly.

From the above it will be apparent that there is a slight twist in the length of strip 4 that is between the press 2 and the strip feed machine 1. In conventional presses, the feed rollers and the punch and die assemblies are more nearly horizontally disposed than in the present instance, the punch assembly reciprocating in a generally vertical direction, which would be objectionable in the present combination with a strip feed device such as shown in FIG. 1 in which the strip is fed from a roll.

The pairs of strip driving and tensioning rollers 33, 34 at each of the opposite sides of the punch and die assemblies are each connected at their upper and lower ends by spur gears that are in gear boxes 39, 40 (FIG. 5) so as to have a positive driving connection with each other. The shafts on which one corresponding roller of each pair 33, 34 is secured projects upwardly from each gear box 39 and mounts an overrunning clutch 42 (FIG. 1). The outer races of these clutches 42 have arms 43 projecting from corresponding sides thereof, and the outer ends of these arms are pivotally connected with opposite ends of a connecting rod 44.

The left hand clutch 42, as seen in FIG. 1, has a second arm 45 projecting at a right angle to the arm 43 on said clutch, and the outer end of this arm carries a ball that is in a socket on one end of a rod 46. The other end of rod 46 is connected with an adjustable pivot on a crank 47 (FIG. 3) that carries the main crank 36.

From the foregoing description, it is seen that upon each rotation of crank shaft 35 to reciprocate the punch assembly 38 the rollers 33, 34 will positively advance strip 4, the arrangement being such that the strip will be advanced only during the period when the punch is clear of the strip. The stroke of rod 46 may be varied by securing the end thereof at the crank 47 different distances from the axis of said shaft, so that a minimum of scrap occurs, as indicated in the skeletal portion of the strip in FIG. 1(*a*).

After discs 3 have been stamped from strip 4 the resultant skeletal portion of the strip is chopped off by the usual scrap cutter that is adjacent to the outfeed side of the press, which cutter is actuated by a rod 47*a* that operatively connects the scrap cutter with the crank shaft 35.

Referring specifically to the punch and die structure (FIG. 4) it is to be understood that the spacing between the punch and die assemblies, when the punch assembly is at its maximum distance from the die assembly, is adequate to permit free ejection of the caps from the punch assembly.

The punch assembly 38 (FIG. 4) comprises a head 48 rigid with the connecting rod 37, and it carries a punch back-up plate 49, thereagainst, and a punch locating plate 50.

In the particular press herein illustrated (FIGS. 1, 3) there are four punch assemblies and four die assemblies for simultaneously forming four caps. One of the punch and die assemblies is illustrated in FIG. 4, and each is alike. Therefore the punch locating plate 50 indicated in FIG. 4 locates the other three assemblies in addition to the one illustrated in FIG. 4. The pattern effected by successive punch operations is seen in FIG. 1*a* in dotted lines. This pattern enables the simultaneous successive punching out of a plurality of blanks in the strip 4 in a pattern at each stamping operation in which the blanks of a plurality of adjacent pairs are equally spaced apart with the centers of two pairs of adjacent blanks being on a pair of parallel lines extending normal to the length of the strip, with one blank of each such pair being at each opposite edge of said strip, and with the other blank in each of said two pairs being spaced apart a distance equal to the spacing between the blanks of each said adjacent pair and on a line that is normal to and bisects a straight line extending through the blanks respectively at each of the opposite edges of said strip. The distance between said parallel lines is substantially equal to but slightly greater than a distance equal to three radii of a blank along a line extending normal to said parallel lines.

By this arrangement, upon movement of the strip 4 longitudinally thereof a distance slightly greater than the diameter of each blank after each stamping operation a

plurality of blanks disposed in lines extending parallel with the strip, and a plurality of blanks on lines extending normal to the strip are simultaneously punched out with each stamping operation and what remains in the strip beyond the punching station is a skeleton structure having substantially an irreducible amount of stock beyond what is required to carry the remains away from the punches so as not to interfere with the punching operations.

Each of the four punch assemblies comprises an annular punch **52** that also functions as a draw ring, which punch is rigid with the head **48** and projects toward the die assembly. A radially outwardly projecting flange **53** at the base end of the punch is seated against the back-up plate **49**, while the opposite end of said punch that faces the die assembly is formed with an axially outwardly facing annular surface **54** that is transversely tapered from the axis of the punch, or the inner edge of the punch, to the outer edge **55** thereof in a direction generally toward the die assembly, although the taper is only approximately 3° relative to a plane perpendicular to the axis of the punch. The edge **55** is the cutting edge that cooperates with a female die on the die assembly for cutting disc **3**.

An annular stripper ring **56** around the punch **52** slidably extends through an opening in a stripper ring holding plate **57**. Spacers **58** are secured at opposite ends to the back-up plate and stripper ring holding plate for supporting the latter spaced from the back-up plate. One such spacer is shown in FIG. 4, although there are a plurality of such spacers, and they support the stripper ring holding plate in parallel opposed relation to the back-up plate **49**.

The axially outwardly facing surface of the stripper ring **56** is approximately flush with the cutting edge **55** of the punch.

A radially outwardly projecting flange **60** on the opposite end of the stripper ring **56** is yieldably held against the inner surface of the spacer ring holding plate **57** by a helical spring **61** that reacts between an axially facing shoulder **62** on the stripper ring and the base flange **53** of the punch.

A knockout plunger **63** is reciprocable within the central bore in the punch **52** and carries a yieldably outwardly urged and outwardly projecting pin **64** coaxial therewith, which pin is retractable under the pressure of the cap but is adapted to exert an axially outwardly directed force on the exterior of the head of a cap when the latter is formed within the punch to insure unseating the cap in the event it should tend to stick on the punch.

The inner ends of the pairs of knockout plungers in adjacent punches are connected by a cross bar **65**, and a helical spring **66** reacts between the cross bar and an axially facing shoulder **67** on each knockout plunger to return the plungers to the position shown in FIG. 4 after each cap is formed. A conventional cam and roller (not shown) actuate each cross bar upon the return stroke of the punch to force the knockout plunger outwardly of the punch to eject the cap on the plunger, and spring **66** returns the plunger after each such actuation of each cross bar, while the stripper ring strips the cap from the punch after each cutting and drawing operation.

An air line **68** connected with a source of air under pressure extends to the punch and die assemblies and downwardly directed air discharge nozzles **69** (FIGS. 1, 4) are supported in positions above the assemblies **38**, **39** for discharge of air under pressure against the caps that are ejected by the knockout plunger **63** after the caps are formed and the punch and die assemblies are spaced apart.

The four punches project through the ring holding plate **57** in two pairs in each of which there is an upper punch and a lower punch therebelow, with the lower punches offset slightly laterally relative to the upper punches so that each of the two nozzles **69** will eject air against both the upper and lower punch of each pair.

A cam actuated valve **70** (FIG. 3) is actuated by a cam on a shaft **35** to open the line **68** to the nozzles **69** for ejection of air from the latter against the caps as soon as the punch and die assemblies are moved apart to thereby blow the caps downwardly from between said assemblies so the caps will clear the assemblies faster than they would fall by gravity, thereby enabling faster operation of the press without danger of the caps being caught between the assemblies.

The die structure of each die assembly comprises a bolster plate **72** rigid on the press, and a die shoe **73** rigid with the bolster plate, which die shoe carries the four die assemblies in positions in which they are respectively in axial alignment with the punch assemblies.

Each die assembly comprises an annular die **74**, cut edge, or female die having a cutting edge **75** that coacts with the cutting edge **55** on the punch **52** for cutting the disc **3** when the punch **52** enters the female die. The stripper ring **56** will, of course, be moved axially against the resistance of spring **61** when it is engaged by the female die.

Within the female die **74** is the draw or presser ring **76**, the annular outer end surface **77** of which is inclined radially to be complementary to the radially inclined surface **54** on the punch **52** and this draw ring is yieldably supported for axial reciprocable movement within the female die, and relative to the die plug **78** that is within the draw ring **76** coaxial therewith.

A plurality of rods **76'** equally spaced around the axis of the draw ring, reciprocably extend through the bolster plate **72**. The draw ring is supported on the upper ends of these rods, and the lower ends thereof are secured in a disc **76''** (FIG. 4) that, in turn, is supported on a rubber cushion **79**. A disc **79'** below the cushion **79** is connected by a bolt **86** with the bolster plate, which bolt freely extends through the cushion **79** and the disc **76''**. By this structure the draw ring will yieldably return to its seated position after each punching operation.

The strip **4** normally will extend across and substantially in engagement with the outer surface of the female die, and the axially outwardly facing surfaces of the die plug and draw ring will be spaced from the axially outwardly facing surface of the female die approximately the thickness of the strip **4**, hence when the punch assembly moves toward the die assembly, the disc **3** will be sheared or cut from the strip **4** along the line of the cutting edges **55**, **75**.

After the disc **3** is cut by each set of the punch-die assemblies, continued movement of the sets of punch assemblies, toward the sets of die assemblies will cause an initial approximately 3° radial bend of the marginal portion of each disc **3** due to the angularly disposed complementary annular faces **54**, **77**.

The final movement of the die plug **78** into the punch **52** will cause the skirt of each cap to be drawn around the die plug as the plug enters the punch, and it is particularly pertinent to note that the direction of the draw is the same as the direction of the original bend caused by the inclined surfaces **54**, **77**.

During the drawing of the skirt of each cap, the knockout plunger **63** will be depressed against the resistance of the spring (not shown) that reacts against a stationary part of the punch and the cross bar **65**, hence upon retraction of the punch, the knockout plunger **63** will return to the position shown in FIG. 4. The cap will be stripped off the die plug and the jet of air from the nozzles **69** will quickly blow the removed caps in a downward direction where they will fall, in indiscriminate arrangement through a chute **80** (FIG. 3) onto a generally horizontally extending, continuously moving conveyor **81** that carries the caps away from the press **2** and that discharges said caps onto a ladder or otherwise suitable conveyor **82**.

Transfer of caps from press to embosser and trimmer

The conveyor **82** elevates the caps to the conventional cap orienting machine **6** (FIG. 1), into which the indiscriminately arranged caps are discharged. The caps

5 are successively discharged from the orienting machine 6 with their open ends directed laterally in the same direction, and when so discharged they fall by gravity in single file through a chute or conveyor 83 successively past a star wheel 84 (FIG. 6) and a solenoid actuated cap stop 85 and on to the embosser and trimmer where one of the revolving laterally directed spindles 87 will enter the open side of each cap for progressively seating the cap on each spindle as the spindles are revolved about the axis of the circular member carrying the spindles.

Before describing the embosser and trimmer, reference is made to FIGS. 6, 7, 8 each of which shows the star wheel 84.

At times a cap 5 may enter the conveyor 83 with its open end facing in a direction opposite to the direction in which it must be positioned in order to receive the spindle 87. This is a seldom occurrence, but if not detected, and if the cap is not removed before it reaches the spindle, there will be a jamming of the cap at the embossing and trimming device that could cause considerable damage, and delay.

As seen in FIGS. 6 and 7 when a correctly positioned cap 5 reaches the star wheel 84, one of the arms or spokes of the latter will enter the open end of the cap permitting the cap to fall to the embosser and trimmer. However, if the cap is reversed (FIG. 8), the cap will be held at the star wheel. One of the sides of the chute at the star wheel is formed with an opening closed by a spring urged door 88 that may be opened to remove the incorrectly positioned cap so that feed to the embosser and trimmer may continue.

The purpose of the cap stop device 85 (FIGS. 6, 7) is to stop the caps from moving to the embossing and trimming machine. It is preferably electrically actuated and may comprise a member 89 that is connected by suitable linkage with the core of a solenoid 90. The coil of the solenoid is in an electrical circuit with a sensing device that, in turn, is in the conveyor system between the embossing and trimming machine 7 and the shaving machine 8. Imminent choking of the conveyor systems between the embosser and trimmer, and the shaving machine, is avoided by energization of the solenoid coil of solenoid 90 to effect a movement of the cap stop 85 that is connected with the solenoid core, to a position across the path of movement of the caps thereby stopping the feed of caps to the embosser and trimmer.

The sensing device illustrated comprises an electric eye device 91 (FIG. 11) that is in the circuit with the solenoid coil.

The lower end of the conveyor 83 is inclined toward the embosser and trimmer, and the side of the lower end of the conveyor 83 that faces the embosser and trimmer is open, and said open side is at the same side of the caps as the open ends of the latter.

Adjacent to the lower end of the conveyor 83, and between the front side of the embossing and trimming machine 7 and the said lower end of conveyor 83, is a spindle actuated cap releasing device. FIG. 9 is a view looking toward the side of the cap releasing device that faces the embossing and trimming machine 7.

The lower end portion of conveyor 83 extends toward the embossing and trimming machine 7 in a downward direction (FIG. 6) and the open sides of caps 5 are progressively carried toward the downward path followed by spindles 87 on the embossing and trimming machine, but are stopped just before reaching the point where the spindles will enter the open ends of the caps, by a projection 93 (FIG. 9) on the end of an arm 94, which arm is pivotally supported at 95 on a side of the conveyor 83.

The end of arm 94 that is opposite to projection 93 is pivotally connected to one end of a link 96, which link, in turn, is pivotally connected at its opposite end to one arm 97 of a crank 98. The other arm of said crank carries a roller 99 that is spaced below projection 93 and that is in the path of travel of spindles 87. The crank 98 is pivotally supported on the conveyor 83 by a pivot 100.

A spring 102 connects the outer end of arm 94 with a bracket that is rigid with the conveyor 83.

The illustrated cap releasing device is a unitary device that may be installed as a unit at the lower end of the portion of the conveyor 83 that extends toward the embosser and trimmer.

This lower end of conveyor 83 (FIG. 9) is open at the side thereof that faces the embosser and trimmer, having a slot 103 extending longitudinally thereof through which the spindles on the embosser and trimmer are adapted to extend so as to enter the open ends of the caps as the spindles move downwardly in a portion of their circular path, as will later be explained. Plates 104 on the conveyor define opposite sides of slots 103 and extend over the edges of the caps 5 at opposite sides of the open end so as to prevent the caps from falling laterally out of the conveyor.

Spaced below the arm 94 and the projection 93 thereon is a stop member 105 in the form of a laterally directed projection on the lower end of a generally vertically extending arm 106. This arm 106 is pivotally supported intermediate its ends on the side of conveyor 83 that is opposite to the side on which the arm 94 and crank 98 are carried. A spring 107 connects the upper end of the arm 106 with a portion rigid with the conveyor to yieldably hold the stop 105 in a position projecting into the conveyor.

In operation, the caps 5 that are moved downwardly by gravity, assisted by an air jet 108 that is directed into the conveyor in a downward direction, will be stopped by the projection 93 before the lowermost cap is in a position to be engaged by a spindle 87. As a spindle moves into the channel provided by the conveyor at a point below projection 93, it will engage roller 99, causing the crank 98, link 96 and arm 94 to swing the projection 93 counterclockwise, as viewed in FIG. 9, thus permitting a cap 5 to drop to the stop 105, and immediately thereafter the roller 99 will be released to permit spring 102 to swing the projection 93 back into the path of travel of the caps.

The cap held by the stop 105 is in a position to be engaged by the next spindle, and the stop 105 will be yieldably swung to the left, as viewed in FIG. 9, as the next spindle moves it downwardly and during such movement the roller 99 will be actuated to release another cap. Thus a cap will be properly positioned by stop 105 and releasably held by such stop for each successive spindle.

Timmer and embosser

Spindles 87 of the trimmer and embosser are alike, and are supported equally spaced in an annular row on a circular vertically disposed carrier 110 (FIG. 12) having gear teeth 112 on its outer periphery. This carrier is supported for rotation on shaft 113, and the teeth 112 thereon are in mesh with the teeth of a motor driven pinion 114.

The rotation of the carrier 110 is counterclockwise, as seen in FIG. 12, hence the spindles will be carried counterclockwise.

Each spindle is rotatably mounted on carrier 110 (FIG. 13) and secured on the shaft 115 that carries each spindle is a pinion 116, the teeth of which are in mesh with the teeth of a sun gear 117 that, in turn, is stationary on shaft 113. Thus, upon rotation of the carrier, the spindles will be rotated.

The outer free end of each spindle is of lesser diameter than the cap that is to be carried thereon for trimming and embossing, so the cap can be readily positioned on said outer end and removed therefrom.

All parts of each spindle 87 are coaxial with its central axis. The outermost end of each spindle is provided with a nose cone 118, the smaller diameter end of the cone being at the outermost end of the spindle adjacent to this

cone and intermediate corresponding cylindrical portions **119** is the embossing tool **120** bearing, in relief, the symbols to be embossed around the skirt of the cap. Adjoining the cylindrical portion **119** that is most remote from the nose cone is the scrap knurling tool **121** that is milled on its outer periphery, and of slightly less diameter than the adjoining portion **119**. The corner or edge of said adjoining portion **119** that is next to the scrap knurling tool will form the shear face for trimming the cap. A cylindrical spacer **122** adjoins the scrap knurling tool.

Rigidly secured by stud bolts **124** to the forward side of the stationary sun gear are two sets of arcuate segments respectively designated **125, 126** (FIG. 12) that are concentric with the axis of shaft **113**. The segments of each set are aligned or in register axially of said shaft **113**, and the two sets of segments are in end to end relation.

The radially outwardly facing surfaces of the sets **125, 126** are substantially in circumferential alignment.

The set **125** may comprise segments **127, 128** and **129** (FIG. 13). The segment **127** functions as a pressure plate, since the outer peripheral cylindrical surfaces **118** of the spindle will tightly press the cap against the outer peripheral surface of the segment **127** at opposite sides of the embossing tool. The segment **127** is relieved to not engage the embossing tool.

The segment **128** is in the same plane as the scrap knurling tool **121** and its radially outer edge or corner that is adjacent to the segment **127** is in shearing relation to the adjacent corner of said segment **127**. The segment **129** is merely a spacing segment that is between the segment **128** and a wear ring **130** on the spindle. The wear ring **130** may obviously be integral with the spacer **122**.

Inasmuch as the principal function of the set of segments **125** is to trim off the uneven marginal portion along the free edge of each cap, and to reduce the skirts of the caps to uniform length, this set may be called the trimmer set, and the segment **128** is the trimmer segment.

The set of segments **126** may be termed the embosser sets, inasmuch as this set includes two segments, **132, 133** (FIG. 14), the segment **132** being formed in its outer periphery complementary to the embossing tool **120** of the spindle insofar as the symbols are concerned. Segment **133** may be merely a spacer. The cylindrical portions **134** (FIG. 14) on segment **132** at opposite sides of the symbols may be the pressure surfaces for holding the cap tight against the surfaces **119** of the spindle.

The caps are positioned on the spindles before the latter pass below a face plate **135** (FIG. 13) that functions to hold the caps on the spindles as the carrier **110** revolves to carry the caps past the sets of segments.

Each spindle **87** is formed with a central open ended, through bore **136** (FIG. 13). One end opens against the head of the cap **5** that is carried on the trimming and embossing end of the spindle, while the other end opens at the rear side of the machine.

As seen in FIG. 12 at the side of the machine **7** that is opposite to the lower delivery end of the cap conveyer **83** the face plate **135** terminates, and the lower end of a transfer cap conveyor **137** extends across the caps. The open side of the lower end of this conveyor **137** is open on its side that faces the spindles and said open side is positioned to receive the caps as the latter are moved axially off the spindles.

A manifold **138** is supported at the side of the machine **7** that is opposite the spindles, and this manifold is connected with a source of air under pressure. The side of the manifold that faces the rear ends of the spindle shafts **115** is formed with a row of small openings **140** that are scanned in succession by the rear open ends of ducts **136** that extend through the spindles.

While the caps may be blown off each spindle as the duct **136** passes the first of the openings in the manifold, it is preferable that the spindle pass several jets of air to positively insure its removal.

In passing the trimmer, the portion trimmed from each cap will be crinkled by the knurling on the scrap knurling tool **121** so as to readily drop from the tool, and after each cap has passed the embossing segments it will be reduced to the proper length and will be embossed with the desired symbols. It then is blown into the lower end of the transfer cap conveyor for being transferred to the shaving machine **8**.

Transfer cap conveyor to shaving machine

Conveyor **137** is similar to conveyor **83** except that it does not have a star wheel and cap stop therealong. The cap is blown off the spindle and into the lower end of conveyor **137**. This conveyor is generally in the form of an inverted U (FIG. 11), the lower end of one leg of which is the end that receives the caps blown off the spindles of the embossing and trimming machine. At the lower end of said one leg is an upwardly directed air jet **139** (FIG. 11) that blows each cap upwardly, and successive booster jets **141, 141*a*** at the side of conveyor **137**, but directed upwardly, will cause the caps to move over the upper curved end of the conveyor **137** for falling by gravity in the other leg of the conveyor. The said other leg, however, is divided into three conveyor lines **143**, that are adapted to feed the caps to three shaving units in the shaving machine **8**.

As the caps fall by gravity to the three lines **143**, they successively pass the electric eye assembly that controls the stop means **90** in the conveyor that feeds caps into the trimming and embossing machine. If the caps in conveyor **137** should pile up in the descending leg to the electric eye control assembly so as to intercept the beam for a predetermined time, and before the caps pile to the curved upper end of the conveyor, the stop means **90** will be actuated to stop the flow of caps from the trimmer and embosser, but as soon as the beam is uninterrupted, the circuit will be closed to again start the flow of caps to conveyor **137**.

Shaving machine

The shaving machine **8** (FIGS. 1, 15) is positioned at the point in the system in which the caps, when presented thereto, have been trimmed to uniform length and the desired symbols have been embossed thereon (FIG. 27). The shaving step is the step in which the outer coating of enamel, and the skin of the metal, to a depth of approximately .001" to .003", is removed so that the outer surfaces of the embossed symbols will have a distinguishing color or characteristic from the remainder of the cap.

Heretofore the coating has been removed by sanding or cutting it off with a rotary cutter or an abrasive wheel, with the accompanying disadvantage of lack of uniformity, dust and slowness of operation, and other objections.

Before describing the shaving machine structure, it is pertinent to note in the steps of the present process or method of forming caps, the order in which the shaving step occurs is important. The shaving is done in a direction generally axially of the caps and in a direction toward the open ends of the caps. Thus the strain placed on the skirt of each cap in said axial direction will not change the axial dimension of the skirt since the skirt is straight from the embossing to the closed head of the cap. A spindle in the cap will contact the inner surface of the head or top of the cap to hold the cap against axial movement as the coating is shaved off the radially outermost surface of the embossing in a direction toward the free edge of the skirt. Were any annular beading or ridges formed in the skirt between the closed end of each cap and embossing, the resistance to shaving off the coating would be sufficient to partially straighten such ridges or beading with the result of elongating the cap skirt axially thereof, and as this would not be done uniformly, the caps would be of different lengths and unsuitable for use. This explains the importance of having the shaving step accomplished while the portion of the skirt between the

embossing and the closed end of each cap is straight in a direction axially of each cap.

Referring to the shaving machine **8** (FIGS. 1, 15–18) the machine operates generally in much the same manner as the press **2**, having a motor in housing **147** that is connected with a crank shaft **148** (FIG. 15) that, in turn, is formed with a crank that is connected with one end of a connecting rod **149**. The connecting rod is connected at its opposite end with a reciprocably mounted head **150**.

The head **150** has three horizontally disposed horizontally spaced punches **151** in a row, and which punches are adjacent to the lower delivery ends of the three conveyor lines **143**.

The caps in said conveyor lines **143** have their open ends facing the punches, and the lowermost cap in each conveyor line is coaxial with each punch, being deposited at the lower end of each of the three lines **143** in a semi-cylindrical upwardly opening recess **152** in a stationary cap supporting and positioning plate **153**.

In the entire system after the caps have been oriented in the orienting machine **6**, they will automatically remain oriented in all of the conveyor lines, since they cannot change their positions in the conveyor lines, and are ejected from the machines **7**, **8**, **9** and **10** in a position to reenter the conveyor lines in oriented positions.

The lower ends of conveyor lines **143** open downwardly into recesses **152** and as each cap is removed the next cap in each conveyor line drops into the recess **152**.

The stationary portion of the shaving machine toward and from which punches **151** are moved with head **150** as the crank shaft **148** is rotated will be called the die head, and such die head is generally designated **154**.

The die head **154** comprises a plate **155** rigidly held on the frame of the shaving machine, and which plate has a plurality of shaving dies **157** secured thereto in positions coaxial with the punches **151**, there being a punch for each shaving die. Each die **157** is formed with an annular cutting edge **158** (FIG. 18) facing each punch, and each die is adapted to receive each punch upon each movement of the head **150** at the end of the stroke of the latter toward the die set, as will be more fully described in describing the operation of the shaving machine. Movement of head **150** toward plate **155** is guided by sliding engagement of posts **160**, on plate **155**, within guide blocks **166** on head **150**.

The cap positioning plate **153** is secured to the plate **155** of the die set in a position closely adjacent to the cutting edges of the shaving dies by bolts **159** (FIG. 17) while rods **156**, secured at one of their ends to the plate **155**, extend through openings in the cap positioning plate **153** to positions past and spaced from the ends of the row of punches **151** (FIGS. 16, 17). These rods **156** carry a stripper plate **161** having openings formed therein that are respectively coaxial with the punches **151** and shaving dies **157**.

Stripper rings **162** (FIG. 18) are yieldably held substantially coaxial with the punches **151** in annular recesses around each of said openings in the stripper plate, and a ring retainer plate **163** holds each ring in each of the said recesses, although each ring is movable radially in each recess against the resistance of the annular yieldable element **164** that yieldably holds each ring substantially coaxial with each punch. The element **164** may be a spring or O-member positioned in a radially outwardly opening recess formed in the outer periphery of each ring **162**.

Each punch is formed with an air relief duct **165** to enable free movement of the caps relative to the punches axially thereof free from either air pressure or vacuum in the steps of positioning the caps on the punches and in removing them.

Also fixedly supported on the shaving machine spaced above each shaving die is a downwardly directed air discharge nozzle **168** and a second downwardly directed air discharge nozzle **169** is adjacent to and above each stripper ring **162** at the side of the latter that faces the die set **154**.

The nozzles **168** are connected with an air line under pressure in which a valve **170** substantially corresponding, both in structure and manner of operation with the cam actuated valve **70** of FIG. 3, so that a blast of air is directed against the caps while they are on the punches **151** immediately following each shaving operation. Thus the shavings are blown clear of the caps before they are stripped from the punches.

Air under pressure is steadily ejected from the nozzles **169** against the caps when the latter are stripped from the punches by the retraction of the punches through stripper rings **162**.

The outer end of each punch **151** is externally relieved at **180**, and the outside diameter of each punch to said relieved outer end portion is substantially equal to the minimum inside diameter of the stripper ring at **181** (FIG. 18) and the inside of each stripper ring is relieved at the side of the ring nearest each retracted punch.

The inside diameter of each shaving die **157** is such that a cap carried on the outer end of the punch **151** opposite thereto will shave off the enamel or coating on the outer surface of the embossing **182** of cap **5** and the skin of the metal (FIG. 18) when each cap is moved into the shaving die by the punch carrying the cap.

A spring loaded cylindrical knockout piece **184** is positioned within each die **157** and an annular flange **185** on the inner end of each knockout piece that is within each die is adapted to seat against an axially facing shoulder within each die to position the outer end of each knockout piece flush with each die. A spring **186** disposed within an opening in plate **155** (FIG. 17) yieldably holds each knockout piece **184** with flange **185** against the positioning shoulder in such shaving die.

In operation, when the caps **183** (FIG. 18) are positioned in the recesses **152** in plate **153**, their open ends face the punches **151**. Upon movement of the punches through and past the stripper rings **162** they will enter the open ends of the caps and will carry the caps into the shaving dies. As the embossing on the skirts pass the cutting edges of the shaving dies the latter will shave off the coating to the metal. The knockout pieces **184** will insure retraction of the caps from the shaving dies as the punches are retracted, and immediately upon the coating being shaved from the radially outwardly facing surfaces of the embossing, the air jets from nozzles **168** will clear away the loose shavings.

Punches **151** will, upon retracting from the shaving dies, carry the caps to the stripper rings where the caps will be stripped from the punches and the air jets from nozzles **169** will quickly blow the caps downwardly and into conveyor **187** for movement in said conveyor to the machine **9** where the skirts of the caps will be further processed.

Transfer conveyor from shaving machine 8 to machine 9

Conveyor **187** extends from below the punch and die assemblies of the shaving machine in an inverted generally U-shaped form similar to conveyor **137** (FIG. 11), except that conveyor **137** is formed with a twist so as to feed the caps to the side of the machine **8** that faces oppositely to the corresponding side of the machine **7**.

A continuously actuated air nozzle **188** (FIG. 17) discharges a jet of air into the end of conveyor **187** so as to blow the caps longitudinally of the conveyor and up one of the upwardly extending legs of the latter where other booster jets similar to jets **141**, **141*a*** in FIG. 11 will insure the caps passing over the arched portion of the conveyor.

In conveyor **187** an electric eye control mechanism **190** (FIG. 1) is in a position in conveyor **187** similar to the position of the electric eye assembly **91** in FIG. 11. However, the control **190** is in the electric circuit with a conventional air actuated clutch, in which interruption

of the beam of assembly **190** by caps in the descending leg of conveyor **187** to approximately the level of the control means **190**, will actuate a solenoid in ain air line connected with the clutch to closet the air line, whereupon the clutch will disengage the shaving machine motor from the press crank shaft to stop the press. The arrangement is such that the press crank will always be stopped upon disengagement of the clutch, at the top dead center of the press, whereby the press will be fully open when it is started again by engagement of the clutch. The solenoid actuated valve will be actuated upon lowering of the level of the caps in the descending leg of the conveyor **187** to open the air line to the clutch for connecting the motor with the crank shaft of the press. This clutch arrangement, including the solenoid actuated valve in the air line, is not illustrated since it is conventional in presses.

As stated above, conveyor **187** carries the caps to the machine **9** where the caps will be operated on as follows:

Knurling machine 9

The machine **9** actually forms an annular bead in the skirt of each cap, and then slits or serrates the bead so formed, centrally thereof, in a direction circumferentially of the latter to form a line of weakness along which the marginal portion of the skirt along its free edge will readily break upon unscrewing the cap from a bottle. Also the knurling machine will form a radially inwardly projecting ridge adjacent to but spaced from the head or closed end of such cap, which ridge functions to retain the liner or sealing washer adjacent to the head after such liner is pressed into the cap from its open end, and a further function of the machine **9** is to form the knurling in the skirt at the head of closed end to provide a roughened surface to facilitate gripping the cap with the fingers for unscrewing it from a bottle.

FIGS. 19–22 illustrate machine **9**, although said machine performs other operations than knurling, it will be referred to as a "knurling" machine for purpose of brevity.

The knurling machine is substantially the same as the trimming and embossing machine, except for the specific structure of the tools on the spindles for forming the beads, cuts, ridges and knurling, and the complementarily formed die structure. Thus the description of the mounting of the spindles and their carrier, etc. will not be duplicated. The description of the structure in the embosser and trimmer will suffice, as will the description of the spindle actuated cap release of FIG. 9.

In the knurling machine (FIG. 19) there are three sets of die segments **191**, **192** and **193** that are arranged in circumferential end to end alignment around the central shaft **194** that carries the spindles, generally designated **189**. The order in which these are arranged is such that the beading segment, in conjunction with the spindles, will form an annular outwardly projecting bead in the skirt of each cap. Then the serrating or slitting segment will cut the slits in the bead that has been formed, while the knurling segment will thereafter form the knurling and the linear retaining bead.

As seen in FIGS. 20, 21, 22, each spindle is provided with an inner beading tool **195** and an outer beading tool **196**. These are positioned on each spindle to cooperate with the beading segment **197** (FIG. 20) to form an outwardly projecting bead in the skirt of each cap adjacent to but spaced from the free edges of each cap. The words outer and inner are used with reference to the outer end of the cap that is adapted to be on the spindle, the outer beading tool being for forming the portion of the bead that is nearest the outer end of the cap.

These two beading tools initially form only one bead. The die portion of the beading segment being merely a single groove of arcuate cross sectional contour, as seen in FIG. 20. However, the inner and outer beading tools meet at their sides in an arcuate angle that forms a recess for the slitting or serrating die segment, as will later be described.

In FIGS. 20–22 the various die segments are spaced from the spindles for clarity. In actual practice the skirt of the cap would be tightly engaged between the spindle and the die segment along which the spindle is rolled.

The die segment **198** (FIG. 20) alongside the die segment **197** has pressure surfaces **199** adapted to tightly engage the skirt of each die, and this segment is relieved to pass the embossing on the cap.

Upon the caps being rolled onto the serrating die group **192**, the single bead will have been formed, and in the serrating die group is a serrating segment **202** (FIG. 21) that carries slightly spaced slitting sections **203** that form circumferentially aligned spaced slits **204** (FIG. 33) in the bead that was formed and this segment also depresses the single bead centrally of its width along the line of the slits that are formed.

It should be noted that the provision is made for pressure surfaces **205** on the die segments **202** as well as the one adjoining it, so as to insure a tight engagement between the spindles and one or more segments of the serrating group.

Upon the beads on each cap being serrated, the cap is rolled onto the knurling group.

Each spindle has the knurling tool **206** on its outer end and adjacent thereto is an outwardly opening recess **207**.

The knurling segment **208** (FIG. 22) is complementary to the knurling tool to form the knurling **209** (FIG. 33) on each cap, and the knurling tool also carries the bead tool **210** adjacent to the knurling portion, which bead tool in association with recess **207** forms the radially inwardly projecting liner retaining bead **211** (FIG. 33).

Segments **212**, **213** (FIG. 22) of the knurling segment group may provide the pressure surfaces to tightly grip the cap on the spindle for rotating the cap with the spindle.

A centering ring **215** (FIG. 20) is carried on each spindle at the end remote from the knurling tool. This ring is yieldably held coaxial with the spindle by a plurality of springs **216** or suitable cushioning material such as neoprene. When each cap is positioned on each spindle, the outer end of the skirt will receive each ring **215**. When the spindles carry the caps past the die segments, the caps will, of course, be eccentrically held on the spindles, and each ring **215** will be yieldably held in the same eccentric position. But as soon as the spindles pass the knurling die segments, the rings **215** will automatically center the caps on the spindles so that the caps will be readily removed from the spindles.

The segment group **192** may be modified so that the knurling and bead forming segment **208** of FIG. 22 is formed on the outer segment of the group **192** that is over the recess **207** and knurling tool **206** of the spindle, thus combining the serrating operation with the knurling and bead forming operation. FIG. 22*a* shows the above modification in segment **214**, and in this instance, of course, the segment **208** of FIG. 22 would be omitted, or at least the knurling and bead forming portions on the outer segment of FIG. 22 would be removed. Otherwise the segments **212**, **213** of group **193** could remain, since they would contribute to a more positive final setting of the previously formed beads in the caps.

At the rear side of the knurling machine, and at the point just beyond the knurling segments, in the direction of travel of the spindles, is a manifold **217** (FIG. 19). Each spindle is formed with a central open ended passageway for air, such as indicated at **136** in FIG. 13, and the manifold **217** is positioned in approximately the same position on the knurling machine as the manifold **138** on the trimming and embossing machine. A row of spaced discharge openings **218** is aligned with the path of travel of the rear open ends of said air passageways in the spindles so that said open ends will scan the discharge

openings **218** to receive successive blasts of air therefrom to insure the caps being blown off the spindles and into the receiving end of a conveyor **219** (FIGS. 1, 19) that leads to the lining machine. An air jet **220** (FIG. 19) at the lower open end or side of conveyor **219** functions to move the caps from the knurling machine to the lining machine.

Transfer conveyor from knurling machine to lining machine

Conveyor **219** is substantially the same type of conveyor as conveyor **187** and booster air nozzles similar to nozzles **140** may be provided to insure delivery of the caps to the lining machine **10**. Also suitable controls such as have been provided along conveyor **219** may be employed to insure against jamming of the system and possible damdamage due to over filling conveyor **219** with caps.

The terminating length conveyor **219** at the lining machine is preferably horizontally extending and the caps are delivered with their open sides directed upwardly onto a conveyor **221** that in turn delivers the caps to the lining machine.

Lining machine

The lining machine **10** (FIG. 1) is a conventional machine that functions to cut the circular discs **11** from a continuous strip **12** from a roll of stock (FIG. 30) and that positions these discs in the caps below the radially inwardly projecting liner bead **211**.

In general, this machine comprises a horizontal circular table **223** that is below and coaxial with a circular cap positioning disc **224** thereabove, and which table and disc are rotatable counterclockwise as seen in FIG. 1. The edge of disc **224** is provided with angularly extending spaced slots **225** into each of which a pair of caps is adapted to be moved by conveyor **221** as the disc **224** is revolved therepast.

The table **223** carries the pairs of caps below a pair of vertically disposed punches and a pair of vertically disposed seating plungers adjacent thereto that are carried by a vertically reciprocable head **226**.

Strip **12** of the lining material passes below the punches **227** (FIG. 30) from a roll **228** of said material that is intermittently actuated in timed relation to the head **226** and table **223** to intermittently present a fresh section of the strip to the punches upon upward retraction of the latter with head **226** and the positioning of a new set of caps below the punches.

Upon downward movement of the head **226** the liner discs are punched out and partially positioned in the caps therebelow while the seating plungers **230** (FIG. 32) will at the same time seat the two previously fitted caps.

The caps in which the liners are fully seated (FIG. 33) are shunted out of the radially outwardly opening slots **225** onto a rotating transfer disc **232** and from the latter onto a conveyor **233** for delivery of the caps to cases for shipment or to any other suitable point.

Conclusion

It has been pointed out that there is a very small space between the adjacent openings in the coil stock strip **4**, (FIG. 1*a*) after successive sets of blanks **3** have been punched therefrom. This spacing is preferably approximately 0.060", and the same spacing occurs between the edges of the strip and the openings therealong.

The modification shown in FIG. 22*a*, in which provision of the knurling and serrating to be accomplished at the same time, has an advantage over the structure in which separate segments are provided for performing this operation, in that the knurling tool on the spindle and the knurling segment form a positive, gear-like driving connection between the cap and the tool and segment that positively prevents any slippage of the cap that would result in improper serrating. Such slippage may occur in instances where the metal may be quite slippery, and the serrating is performed separately from the knurling.

It is to be understood that various changes, modifications, and additions that will occur to those skilled in the art are intended to be included within the scope of the invention as defined in the appended claims.

I claim:

1. The method of forming metal caps of the type having a cylindrical skirt and a head integral with said skirt closing one end thereof only and open at the opposite end for receiving the neck of a container therein, that comprises the steps of:

(a) drawing circular metal discs to the form of substantially uniform caps each having a circular head and a cylindrical skirt coaxial and integral therewith;

(b) moving said caps along a first predetermined path of travel to a cap trimming and embossing station;

(c) trimming the skirts of said caps at their open ends to a uniform length and embossing them at said trimming and embossing station with symbols positioned between their ends;

(d) moving said caps along a second predetermined path of travel to a shaving station;

(e) shaving off the radially outermost surfaces of the embossing defining said symbols, at said shaving station, and thereafter

(f) moving said caps along a third predetermined path of travel to a beading, cutting and knurling station, and at said service station performing on each cap the steps of;

(g) forming a radially outwardly projecting annular bead coaxial with each skirt in the path thereof between said symbols and the open end of the skirt; cutting each of the beads so formed approximately centrally of its width and circumferentially thereof along spaced lines in end to end relation; forming a radially inwardly projecting annular liner retaining bead in each skirt adjacent to the head thereon; knurling said skirt between said liner retaining bead and said head, then;

(h) moving said caps from said beading, cutting and knurling station along a fourth predetermined path of travel to a lining station;

(i) seating a circular liner within each of said caps in a position between the liner retaining bead and the head adjacent thereto and finally;

(j) removing said caps from said lining station.

2. The method as defined in claim **1** in which:

(k) the aforesaid operations on said caps at said stations are performed substantially in timed relation to each other to effect substantially continuous movement of said caps from the first mentioned of the aforesaid steps to the last mentioned step.

3. The method as defined in claim **1** that includes:

(k) stopping the movement of said caps in said first path and said shaving step respectively upon a predetermined number of caps being in said second path and in said third path to thereby control the number of caps adapted to move per minute to said trimming and embossing station and to said beading, trimming and knurling station.

4. The method of forming a metal cap of the type having a cylindrical skirt and a head integral with said skirt closing one end thereof only, and which skirt is embossed with symbols and is adapted to be formed with a radially projecting bead between said symbols and said head that comprises the steps of:

(a) drawing a circular metal disc to the form of a cap having a circular head and a cylindrical skirt coaxial and integral therewith;

(b) embossing said skirt with said symbols in which said symbols are spaced between opposite ends of said skirt leaving the cylindrical portion of said skirt between said head and said symbols free from deformation thereof; then

(c) progressively removing the radially outermost surface of the embossed symbols only, under a cutting force directed generally axially of said skirt away from said head while holding said head against movement of said cap in the direction of said force whereby the axial strain on said skirt due to said cutting force will be substantially localized to said undeformed cylindrical portion.

5. The method of forming metal caps of the type having a cylindrical skirt and a head integral therewith closing one end thereof only, that includes the steps of:

(a) drawing circular metal discs having a coating on one of the sides thereof to the form of substantially uniform caps each having a cylindrical skirt and a head closing one end only thereof and integral therewith, and with said coating on the outer surface of said skirt;

(b) continuously moving said caps in a row thereof in side by side parallel engaging relation longitudinally of said row to a trimming and embossing station with the heads on said caps aligned longitudinally of said row;

(c) stopping movement of said caps in said path at a point adjacent to said station, then

(d) intermittently moving said caps from said point in uniformly spaced relation and at a uniform rate of speed through said station,

(e) trimming said skirts to uniform length and embossing them with symbols projecting axially outwardly of each skirt during said movement through said station, then

(f) moving said caps at a substantially accelerated speed in single file along a predetermined path of travel toward a shaving station;

(g) dividing said single file of caps into a plurality of separate files adjacent to said shaving station, then

(h) simultaneously removing said coating from the radially outermost portions only of said embossed symbols on a cap from each of said plurality of files, at uniformly spaced time intervals,

(i) moving the caps from said shaving station in a single row to a beading, cutting and knurling station, for beading, cutting and knurling of caps at said station.

6. The method as defined in claim 5 that includes the step of:

(j) stopping the movement of any cap in said first path of travel the head of which is not in said alignment with the heads on the remainder of caps in said row until the misaligned cap is removed from said path.

7. Cap forming apparatus that comprises, in combination:

(a) roll supporting means for supporting a strip of cap forming metal wound in a roll and which strip has a coating on one side thereof of color characteristic different from that of the metal of the strip;

(b) a punch and draw press including punching and drawing means actuatable on said strip to punch circular discs therefrom and to draw said discs to form caps each of which has a cylindrical skirt and a head closing one end only thereof with said coating on the outside of said skirt;

(c) said punch and draw press including strip drawing means engageable with a length in extension of the outer coil of a roll on said roll supporting means for drawing said strip from such roll and for positioning the portion so drawn to be punched into said discs to be drawn into said caps by said drawing means;

(d) a trimming and embossing machine having trimming means for trimming the skirts on caps formed by said punch and draw press to uniform lengths, and having embossing means for embossing such skirts with embossed symbols in a position spaced between the ends of each cap;

(e) a first conveyor means extending between said punch and draw press, and said trimming and embossing machine for conveying caps from the former to the latter;

(f) a coat removing machine including coat removing means actuatable for movement along a path for cutting said coating off the radially outermost portions of the symbols embossed on each cap to expose the metal of said cap, said coat removing means including cap receiving and positioning means in a position relative to conveyor means for receiving caps from the latter and positioning them in the path of said cutter for so removing the coating on said outermost portions by said cutter;

(g) second conveyor means extending between said trimming and embossing machine and said coat removing machine for conveying caps from said trimming and embossing machine to said cap receiving and positioning means of said coat removing machine,

(h) a beading, cutting and knurling machine including bead forming means for forming coaxial beads on said skirt of each cap at opposite sides of the symbols adapted to be embossed thereon; cutting means for cutting spaced, elongated cuts in end to end relation in the bead that is formed at the side of said symbols opposite to said head; and knurling means for forming knurling in said skirt around said head of each cap;

(i) third conveyor means extending between said coat removing machine and said beading, cutting and knurling machine for conveying caps from said coat removing machine to said beading, cutting and knurling machine;

(j) a cap lining machine including cap lining means for seating a circular liner disc in each cap after it has been beaded, cut and knurled,

(k) fourth conveyor means extending between said beading, cutting and knurling machine for conveying caps to the latter from said beading, cutting and knurling machine;

(l) actuating means connected with said punching and drawing means, strip drawing means, trimming and embossing means, coat removing means, bead forming, cutting and knurling means, and with said cap lining means, respectively, for actuating therein; and

(m) means operatively associated with each of said conveyor means for moving said caps therealong.

8. In the combination as defined in claim 7;

(n) said first conveyor means including a cap orienting means therein adapted to position the caps from said punch and draw press in single file in side by side relation with their heads in alignment; and

(o) said first conveyor means further including a control means adapted to be engaged by the head of a misoriented cap in the portion of said second conveyor between said cap orienting means and said trimming and embossing machine and actuated by said head for stopping the movement of caps in said second conveyor means to said trimming and embossing machine until said misoriented cap is removed.

9. Apparatus for making pilfer-proof metal caps each having a cylindrical skirt open at one end thereof and closed at its opposite end that comprises the combination of:

(a) separate means for:

(1) trimming said skirts to a uniform length,

(2) forming radially outwardly projecting embossed symbols in an annular row spaced from but adjacent to said open end;

(3) shaving off the outermost metal surface from the radially outermost portion of said symbols to a uniform depth,
(4) forming an annular radially outwardly projecting relatively wide bead around each skirt between said symbols and said open end,
(5) forming an annular row of straight cuts in spaced end to end relation in said bead extending circumferentially of the latter,
(6) forming a radially inwardly projecting annular bead in said skirt adjacent to but spaced from said head of each cap,
(7) knurling said skirt between said cap and said radially inwardly directed bead and
(8) seating a circular liner within each cap between said radially inwardly projecting bead and said head and substantially against the latter, and

(b) means operatively connected with said separate means for maintaining a substantially continuous movement of said caps from the means for seating liners in said caps.

10. In the combination as defined in claim **9**:

(c) said means for trimming and embossing each skirt being incorporated in one machine and said separate means for forming said outwardly projecting bead, for forming said cuts in said bead, for forming said inwardly projecting bead and for forming said knurling, being incorporated in another machine separate from said one machine, and

(d) said means for shaving off the outermost metal surface of said symbols being disposed between said one machine and said other machine, and

(e) conveyor means extending between said one machine and said means for shaving off the outermost surface of said symbols and said other machine for conveying caps between said machines.

11. The method of forming metal caps from a strip of sheet metal that is wound on itself to form a roll thereof that includes the steps of:

(a) unwinding said strip from said roll thereof;

(b) stamping cap-blanks from unwound portion so unwound from said roll at points uniformly and closely spaced from each other in directions transversely and longitudinally of said strip;

(c) forming said cap-blanks into caps immediately after each cap-blank is so stamped from said strip;

(d) supporting said unwound portion of said strip extending horizontally but disposed generally vertically transversely thereof at the points where said cap-blanks and caps are formed, whereby said caps will fall by gravity when released;

(e) rotatably supporting said roll substantially horizontally along one of the edges of the strip thereof with the axis of rotation of said roll generally vertical during unwinding of said roll and during said stamping of said blanks, whereby said strip will be disposed generally vertically transversely thereof in the roll and in said portion thereof substantially free from tension.

12. The method of forming metal caps from a strip of sheet metal that is wound on itself to form a roll thereof providing an outer end at the outside of said roll and an inner end within said roll that includes the steps of:

(a) unwinding said strip at one of the ends thereof from said roll;

(b) stamping cap-blanks from the unwound portion thereof at points substantially uniformly and closely spaced from each other in directions transversely and longitudinally of said strip from substantially said outer end to substantially said inner end;

(c) forming said cap-blanks into caps of the type having a cylindrical skirt and a head integral with said skirt immediately after each cap-blank is stamped from said strip;

(d) forming a radially outwardly projecting annular bead adjacent the lower edge of each skirt and coaxial therewith; slitting each of the beads so formed approximately centrally of its width and circumferentialily thereof to form a plurality of slits in spaced end to end relation; and then

(e) sealing a circular liner within each of said caps adjacent said head.

13. The method of forming metal caps from a strip of sheet metal that is wound on itself to form a roll thereof providing an outer end at the outside of said roll and an inner end within said roll that includes the steps of:

(a) unwinding said strip at one of the ends thereof from said roll;

(b) stamping cap-blanks from the unwound portion thereof at points substantially uniformly and closed spaced from each other in directions transversely and longitudinally of said strip from substantially said outer end to substantially said inner end;

(c) forming said cap-blanks into caps of the type having a cylindrical skirt and a head integral with said skirt immediately after each cap-blank is stamped from said strip;

(d) embossing the skirts of said caps with symbols;

(e) shaving off the radially outermost surfaces of the embossing defining said symbols;

(f) forming a radially outwardly projecting annular bead about the lower edge of each skirt and coaxial therewith; cutting each of the beads so formed approximately centrally of its width and circumferentially thereof along spaced lines in end to end relation; and then

(g) sealing a circular liner within each of said caps adjacent said head.

14. The method of forming a metal cap of the type having a cylindrical skirt and a head integral with said skirt closing one end thereof only, and which skirt is embossed with symbols and is adapted to be formed with a radially projecting bead between said symbols and said head that comprises the steps of:

(a) drawing a circular metal disc to the form of a cap having a circular head and a cylindrical skirt coaxial and integral therewith;

(b) embossing said skirt with said symbols in which said symbols are spaced between opposite ends of said skirt leaving the cylindrical portion of said skirt between said head and said symbols free from deformation thereof; then

(c) removing the radially outermost surfaces of the embossed symbols only; and

(d) forming a radially projecting liner retaining bead in said portion adjacent to said head after said embossing step and the removal of said outermost surfaces.

15. The steps of the method as defined in claim **14** that includes:

(e) the step of trimming said skirt along the free edge thereof that is opposite to said head to a predetermined length before said embossing step.

16. The method of forming caps from a coil strip of sheet metal of uniform width that is wound on itself to form a roll thereof that includes the steps of:

(a) unwinding said coil from said roll to provide a portion for stamping circular cap-blanks therefrom;

(b) successively stamping out a plurality of adjacent pairs of circular cap-blanks of uniform size from said portion of said coil strip in a pattern at each stamping operation in which the blanks of said adjacent pairs are equally spaced apart a distance substantially greater than the radius of each blank with the centers of two pairs of adjacent openings be-

ing on a pair of parallel lines extending normal to the length of said strip, with one opening in each such pair being at each opposite edge of said strip, with the other opening in each of said two pairs being spaced apart a distance equal to the spacing between the blanks of each adjacent pair and on a line that is normal to and bisects a straight line extending through the openings respectively at each of the opposite edges of said strip and the distance between said parallel lines being substantially equal to but slightly greater than a distance equal to three radii of each blank along a line extending normal to said parallel lines;

(c) advancing said portion in a direction away from said roll between each stamping operation a distance substantially equal to but slightly greater than the diameter of each blank, whereby a plurality of relatively widely spaced cap-blanks will be provided at each stamping operation with a minimum of waste;

(d) forming said cap-blanks into caps immediately after each cap-blank is so stamped from said strip, and

(e) advancing said portion in a direction away from said roll after each stamping operation a distance substantially equal to, but slightly greater than, the diameter of each blank to leave between the openings formed in said portion by successive stampings

of cap-blanks therefrom only a substantially sufficient amount of strip-stock to be moved with said portion upon each said advance of the latter between each stamping operation.

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