ABSTRACT OF THE DISCLOSURE

An apparatus and method are provided for forming sheet materials into containers and the like which also includes means for packaging a product within the formed container during the forming operation. In one form of the invention, a container member is formed between cooperating dies and a fluid product is dispensed into the container member directly through the forming die. In another form, material to be packaged is disposed on a flat sheet which is moved past a die containing sheet material formed therein and operative to form an enclosure for said material from both said sheet materials. The apparatus also includes a sheet forming means comprising a rotary array of female dies cooperating with male dies for automatically forming articles such as packaging components.


It is a primary object of this invention to provide a new and improved automatic apparatus for forming packaging.

Another object is to provide new and improved automatic sheet forming apparatus which may be used in the fabrication of improved types of packaging on an automatic basis without the need for human handling. Another object is to provide improved package forming apparatus which includes means for automatically filling or partially filling containers or the like formed by said apparatus.

Another object is to provide automatic machinery for continuously forming sub-packages or small containers which are generally packaged in a master carton or larger containers, said apparatus including means for welding or bonding the containers to a base sheet or a wall of the master carton and the means for automatically forming or partially filling said sub-containers.

Another object is to provide improved package forming and filling apparatus which may be made to operate continuously without interruption for the manufacture of sheet articles.

The invention also consists of certain new and original features of construction and combination of parts hereafter set forth as claimed.

The nature of the invention, as to its objects and advantages, the mode of its operation and the manner of its organization, may be better understood by referring to the following description taken in connection with the accompanying drawings forming a part thereof in which:

FIG. 1 is a fragmentary detail in sectioned end-elevation of aligned sheet forming dies comprising part of the invention;

FIG. 2 shows the sheet forming dies of FIG. 1 brought together;

FIG. 3 illustrates the sheet forming dies brought apart with the component formed thereby retained by one of said dies;

FIG. 4 is a sectional view of one of the dies of FIG. 3 in the act of welding the part formed thereon to another sheet;

FIG. 5 is a fragmentary view of the product formed by the apparatus of FIGS. 1 to 4;

FIG. 6 is an end-elevation of a fragmentary detail of an alternate design for the die of FIG. 4;

FIG. 7 is an end-elevation of a further die design replacing one of the dies of FIG. 4;

FIG. 8 is an isometric view of an automatic packaging machine utilizing components of FIGS. 1 to 7;

FIG. 9 is a side elevation of a further modification to part of the apparatus of FIG. 8;

FIG. 10 is an elevation in section of a plurality of sheet forming dies provided in accordance with the teachings of FIGS. 1 to 7;

FIG. 11 shows the dies of FIG. 10 in closer proximity with the members formed thereby being welded to a base sheet in accordance with the teachings of FIGS. 1 to 7;

FIG. 12 is a fragmentary detail of a sheet forming and welding apparatus shown in the act of forming a container from a first sheet of material;

FIG. 13 is a fragmentary detail of the apparatus of FIG. 12 with the formed sheet component removed from the female die of said apparatus;

FIG. 14 is a fragmentary detail of the apparatus of FIG. 12 shown in the act of welding the component formed thereby onto a second sheet material;

FIG. 15 is a side elevation in partial cross section showing further details of the apparatus of FIGS. 12 to 14;

FIG. 16 is an end elevation of the apparatus of FIG. 15;

FIG. 17 is a fragmentary detail in section of a modified die utilized in the apparatus of FIGS. 12 to 16; and

FIG. 18 shows the dies of FIG. 17 in the act of welding the sheet component formed thereby onto a second sheet.

FIGS. 1 to 3 illustrate in cross-section portions of a male and female die adapted to coact to form a packaging member such as an open cup from a sheet of deformable material such as plastic, metal or foil and FIG. 4 shows the male die member thereof coacting with another die in welding said cup to a second sheet material. In other words, the same die member used to shape the sheet material into a container, is also used to effect welding of said container to a second material. Such apparatus, modified in shape, may also be applied to the forming and welding of articles other than packaging containers or the simultaneous forming, die cutting and welding of two or more members from sheet metal, plastic or laminates.

The resulting welded assembly is illustrated in FIG. 5 which shows a cup-shaped container 20 secured by means of a weld 23 to a base sheet 24. If the sheet 24 comprises a portion of the wall of a container or a shelf portion of a box container, the weld 23 will serve to prevent movement or shifting of the cup therein and may serve as a shock absorbing means for the container and contents. The weld 23 may be of any suitable shape, although if provided as a spot weld of small area, it may retain the container 20 on 24, yet be capable of being torn or ruptured to permit removal of the container and its product by hand.

In FIG. 1, a thin sheet 19 of deformable material is provided on the surface of a plate or female die 17 and is preferably held thereon by means of rollers or other clamping means (not shown). A male die 10, part of which is illustrated, has a tapered nose 12 adapted to
cooperate with the walls of a cavity 18 in a female die 17 and is adapted to shape sheet 19 therein when member 10 is aligned with 18. Base 25 preferably contains provided thereon a row or rows of male die portions such as 12 which may be frusto-conical or otherwise shaped for forming said cups. The external surface of 12 and wall 18 of the cavity 18 may also be shaped to provide corrugations in the wall of the container 20 for the purpose of stiffening said wall 18. The nose 12 and cavity 18 may be formed into any suitable shape and may be rectangular or semispherical. If the sheet 19 is made of a metal such as aluminum or aluminum foil, it may be easily deformed into the cavity 18 in the nose 12 as shown in FIG. 2, provided that it is not completely restrained. The sheet 19 may also be made of a plastic material or a laminated plastic and metal foil. If the material 19 is a thermoplastic or lamination of a thermoplastic and foil, it may be formed into the shape illustrated in FIG. 5 by the application of heat either to the female die 19 on which it rests or by means of a radiant heater applied above the die just before 10 advances over cavity 18. In FIG. 3, the die 10 is shown retracted from 17 so that its end clears the upper surface of the female die. The cup 20 is shown held against the surface of the nose 12 and is carried therewith over a suction bar 25 as illustrated in FIG. 4. The two dies 10 and 25 connect to effect a spot weld 26 between the bottom 22 of 20 and the sheet 24. The notation 17' refers to a hole through the female die 17 extending through the bottom wall of the cavity 18 to which suction pressure may be applied, which pressure may be utilized to perform either or both of two functions. The vacuum pressure applied through 17' may be utilized to hold the sheet 19 against the upper surface of die 17 or to assist in the formation of the cup. For example, if the sheet 19 is made of a thermoplastic material which is in a semi-molten condition prior to the advancement of 10, the plastic over the opening in 18 will be drawn into the die, which action may be completed or partially effected before the die nose 12 advances into said cavity. The die nose 12 may therefore either be used to effect the complete formation of the cup or to assist in the final stage of its formation as well as to effect the transfer of the finished article and its welding to the sheet 24. A plurality of die-formations similar in shape to 12 or of different respective shapes may be provided in a row or rows or in any required array on a single die-block 10 for simultaneous formation of a plurality of cups similar to that shown in FIG. 3 in abutment with the male die portion 12 upon removal from the cavity. The die-block 17' is provided with plural cavities such as 17 each adapted to mate with a respective male die nose. The male die portions 12 may be provided on a rectangular block or in a cylindrical array as described hereafter. If the nose portions 12 are rectangular in cross-section rather than tapered as shown, the formed open container 20 will remain thereon due to friction upon removal of 12 from cavity 18 without the need for applying a suction pressure between the die and the cup. The notation 12' refers to a cavity in the end of the nose portion 12 of the die 10 which may be used to perform either or both of two functions. Said cavity 12' may be utilized to connect with a pressure welding tool tip as hereinafter described. It may also be shaped with outwardly tapering side-walls in a manner whereby the cup formation 20 will be held against 12 when the latter is moved from the cavity 18 in 17. The shape of 12' may be such that it will so maintain 20 against 12 when the dies separate, yet permit the removal of 20 therefrom after the base 22 of 20 is welded or adhered to the base sheet as illustrated in FIG. 5. The cavity 12' in 12 may also preserve the dual function of effecting the pressure welding of the base 22 of 20 to a second member and maintaining said container on the die until said weld is effected for transportation over said second member. The male die 10 is also provided with means for trimming the resulting cup shaped container 20 from the surrounding sheet so that all that remains is a bowl with a circular rim as illustrated in FIG. 3. Said trimming may be effected by means of a circular cutting die or knife 13 which is held in an angular cavity surrounding the die nose 12 and which projects beyond the surface of that part of 10 which surrounds the nose which is referred to by the notation 11. The notation 15 refers to an annular washer of rubber which is bonded to the face of 14 and normally projects beyond the face 11 which serves to separate the scrap material 19' from the material of the cup 20 when the die is lifted as shown in FIG. 3. The notation 16 refers to a hole through the nose 12 and base 11 of the die 10 which extends to the face of the nose from a control valve (not shown) which valve is connected to both fluid suction and pressure means. Suction pressure applied on the line 16 will hold the cup formation 20 against the male die 10 as illustrated in FIG. 3 so that it will be removed thereby from the cavity and can be transported through a fastening or welding station such as illustrated in FIG. 4.

In my U.S. Patent 3,035,382 the packaging structure illustrated in FIG. 5 is provided which may comprise a plurality of cup shaped containers 20 each of which has a corrugated side wall 21 and flat bottom 22 with the bottom of each container secured to a base sheet 24 by welding or bonding by means of an adhesive or fusion of one or more heated thermoplastic materials. The term "bond" here used is hereafter shall therefore refer to securing of the container to the base or retaining sheet by means of an adhesive or welding. The base sheet 24 may comprise a wall of a master container against which a number of the smaller containers 20 are held by welding or other means and are each adapted to retain a material or other product therein. If the material contained by each cup shaped containers 20 is a single portion of foods such as a cupcake, it will quite often be desired to remove the container with the product in order to retain said product until it is eaten or otherwise dispensed of. The bottom 22 of each container is therefore removable secured to the base sheet 24 by means of an adhesive placed between the two or a spot weld such as 23 having a characteristic such that the container 20 may be removed from 24 by hand without difficulty by means of a simple pulling action wherein in the weld 23 is broken or torn. The same master container 10 which forms a base to each individual base sheet 24 may be utilized to effect said weld 23 in a continuing operation after it is formed without removal from the nose 12 of the forming die.

When the die 10 retracts, the spot weld 23 between the bottom 22 and sheet 24 will retain the cup 20 against 24 and separate the nose 12 of the die from said container 20. For certain applications it may be desirable to apply a positive pressure to the duct 16 to facilitate removal of the die nose 12 from the corrugated cup 20. A fast setting adhesive may also be applied as a spot to either or both the abutting faces of 22 or 24 which adhesive will removable retain 20 on 24 when it hardens. If a non-drying pressure sensitive adhesive is utilized, then it will be required to apply a positive pressure to the line 16 in order to separate container 20 from the nose 12 before the die is lifted therefrom, to repeat the cycle of operations.

FIG. 6 shows the design of modified dies for effecting the resistance of ultrasonic welding of the materials of the cup 20 and a base sheet referred to by the notation 35. It is assumed that the male die 30 has been used to form the cup-shaped foil container by the method of FIGS. 1-3 or the like and that therefor advanced said container held thereon by mechanical or suction means against the upper face 35 which is shown abutted against a flat surface of the die block 36. A bore is provided through the
male die base 31 and the nose portion 32 thereof. Inserted in said bore is an insulating sleeve 33 of any suitable material which holds an electrode 34 therein having a tip 34' which projects slightly beyond the edge of the nose 32 or 31 with a moveable protrusion 35 through a member whereby it may be used to compressively engage the upper surface of the bottom of the container 20. Electrical or ultrasonic energy applied between the electrode and the platen 36 which is grounded at 36' if generated at the correct frequency and intensity while the tip 34' of the transducer 34 comes into contact with the bottom wall of 20 against 35 may be utilized to effect a spot weld 23' between the materials of 22 and 35. The retaining action of the weld and/or pressure applied through a bore such as 16 may be utilized to separate the die from the cup when the die 10 lifts away from 25.

Resistance or magnetostrictive welding means may also be utilized to effect a spot weld between the sub-container 20 and the base sheet 24 whereupon notations 34 would refer to a resistance or magnetostrictive welding electrode. If the materials of either 20 or 24 are thermoplastics or are coated or laminated with thermoplastic material, the electrode 34 may be a resistance heating element or rod which protrudes from the end of die nose 12 adapted to apply sufficient heat to the bottom 22 of 20 to melt said thermoplastic material in the immediate vicinity of the electrode for effecting said spot welding.

An embossed container is illustrated in FIGS. 1 to 4, noted, reference being made to the same drawings. It has been proposed that the duct 16 may be used as a means for applying a suction or positive pressure to the container formed on the nose 12, for either maintaining it against said nose during removal from the cavity of the die 17 or for helping to force it off said nose after said container has been secured to the base sheet 24. The duct 16 may also be used for the passage of a liquid or other fluid material therethrough for partially filling the container 20 after it has been secured to the base sheet 24. The liquid may be any flowable liquid which is gated through a valve which is controlled to operate either while the die 10 is in the act of retraction from the sheet 24 after the weld is effected or when 10 has completely withdrawn from the interior of the container 20. The fluid or liquid passed through 16 to be contained by the corrugated container 20 may also be used as a means for supplementing the action of separating the sheet container 20 from the nose 12 of the die. The single duct 16 may be used to perform two or more of the multiple functions described by the use of a multiple position valve in the line 16 or tubing connected thereto which communicates to a source of pressure, vacuum or pressurized liquid. A plurality of ducts 16 extending through the nose 12 of 10 may also be utilized for faster filling of the container or to perform a respective and different of the mentioned operations.

In FIG. 1 the notation 17' refers to a duct or passageway provided through the female die 17 and exiting on the bottom wall of the cavity 18. Positive and/or vacuum pressure may be applied to the duct 17' for either aiding in the ejection of the container 20 or helping to form said container during the initial phase of the movement of 12 in 18. If the material 19 is a thermoplastic which has been heated to a molten condition the die 17 may be utilized as a vacuum forming mold by the application of a negative pressure to the line 17' after the sheet 19 is heated, to draw said material into the cavity 18 prior to or as the nose portion 12 descends therein. The formation 20 may thus be completed or partially completed by the time 13 advances into the cavity.

In a further proposed embodiment, the die sections of FIGS. 1 to 4 may comprise injection mold halves or mold sections for forming the section 20 by injection molding a plastic material. The notation 16 may represent the gate portion of the mold cavity which would be reduced in cross-section where it exits so that the gate will break off after the molded section 20 is secured to the base sheet as in FIG. 5 and the nose 12 is removed therefrom.

The semi-molten or solid condition of the base 22 or 20 immediately after being molded or vacuum formed may be utilized in effecting a bond between said formed cup and the base sheet 24 by application of sufficient pressure between the die 10 and the members 20 and 24 against a platen or die such as 25 as shown in FIG. 4. The bottom 22 of 20 may be kept in a semi-molten condition after the formation of 20 or may be heated to effect the heat welding of 22 to 24 where the use of the sub-container 20 by conventional means just prior to or after the formation of the cup 20. A resistance heating element may be secured in the nose 12 or an electrode connected to a source of high frequency energy electronically effecting the weld 23. The spot bond may also be effected by applying a spot of pressure sensitive or drying adhesive material to the upper surface of 24 or the bottom of 22 prior to bringing the two together or by providing a heat sealable plastic such as the polyvinyl chloride composition known as Vridene A either of said surfaces and melting said plastic with heat applied to either the bottom surface of 24 or upper surface of 22.

Another welding arrangement is illustrated in FIG. 7. The cup 20 is shown formed on the nose of a male die 10' and is shown in abutment with a sheet of material 35. The sheet 35 is shown laminated to a sheet 40 of greater thickness, the assembly being bonded by cementing bonds 37. The notation 39. The notation 35' refers to an adhesive between 35 and 39 provided for holding the two together as a laminated or sandwich construction. The material 49 may be cardboard or plastic and a hole 40H is provided therethrough so that an electrode 34', which is mounted in a tubular insulator 35' will reach the bottom surface of the sheet 35. The electrode 34', which is secured to the press platen or die bed 38, has its tip projecting sufficiently above the upper face of 38 or is projectable therefrom so that it will compress the sheet 35 against the bottom surface of 20. When electrical or ultrasonic energy is applied by means of 34' to the face of 35 it will effect a weld between 35 and 20 and the assembly may be lifted off 38 to clear the end of the electrode 34', or the latter retracted after welding.

It is noted that the laminated assembly or sheet 49 may be used for the base sheet of the configurations of FIGS. 4 and 6 if, where necessary, said openings are in the sheet 40 to permit each die or welding tool to pass to the metal portion of the combination. If the material comprising 20 is a thermoplastic material or is coated with a thermoplastic material then the electrodes 34 and 34' preferably control the necessary heating elements to effect a spot weld between two surfaces which are in abutment with each other.

The welding apparatus illustrated in FIGS. 1 to 7 may for the automatic assembly and filling of such products be applied in an integrated assembly and filling machine as boxed candies, baked goods such as cupcakes and the like, various types of foods such as individual portions of fresh fruits, cooked or semi-cooked foods such as vegetables, desserts, ice cream or the like. In FIG. 8 the basic components of an automatic package forming and filling machine are illustrated which utilizes said base sheet as the eventual package as a means for conveying a plurality of small containers fill pasting apparatus and into a shipping or master carton. In FIG. 8 a plurality of the heretofore described foil or sheet containers are simultaneously formed and are simultaneously positioned on and welded to a base sheet which is continuously fed from the base sheet acting as a conveyor for therefor moving and repositioning said containers relative to product filling apparatus. The base sheet with the filled or partially filled product contained in the containers welded thereon may then be passed through further processing apparatus such as a heating oven or zone, whereafter it may be further processed by cutting into a predetermined length and/or shaping it into at least part of a container. In FIG. 8 the
predetermined lengths of the base sheet are automatically loaded into open boxes as they are cut, their operation eliminating substantially all of the manual operations previously required for a similar type of packaging operation.

Before more fully describing the apparatus of FIG. 8, it will be noted that the supply of the base sheet from the large roll has a continuous sheet which is provided in FIG. 8, may be replaced by a plurality of shorter sheets of the same material with an intermittent feed thereof on to a conveyor to effect substantially the same function of the apparatus in FIG. 8.

FIG. 8 illustrates automatic packaging machinery for forming, assembling and filling containers of the type heretofore described such apparatus illustrated in part in FIGS. 1 to 7. A sheet 51 of a first material such as metal foil, plastic or laminate of these two per se or with paper board, or paper is fed from a supply 50 into a forming press having a bed 54 against which a portion of the sheet 51 is compressed and deformed into cavity therein by means of dies such as heretofore described which are secured to a bed 55. The bed 55 is adapted to be moved up and down on tracks, arms or guides 58 extending downward from an overhead carriage 56 which is adapted to be moved longitudinally along tracks or guides 57 which are supported from the heretofore described means such as hydraulic actuators (not shown) are interlocked in their operation and automatically controlled to advance and retract the die assembly 55 to form cup shaped containers from sheet 51 and to transfer the containers so formed on the male die portions to a position over a bed 61 of a fastening or welding press. A plurality of powered rollers, two of which 52 and 53 are shown, are automatically controlled in their operation to feed and preposition lengths of the sheet 51 beneath forming press 55, to hold said sheet in place against said press and to effect removal of the scrap from the press.

A second sheet of material 60 feeding from a second supply roll 59 is advanced over the press bed 61 onto which a plurality of the containers 20 are placed when the press bed 55 aligns with and advances towards 61. The containers or cups 20 are secured in a predetermined array of rows on 60 by one of the heretofore described means. The base sheet or laminate 60 is then driven power as an elongated belt by aligned pairs of power rotated drive rolls represented by the notations 62 and 63 which are mounted on bearings supported by a frame (not shown) and are driven by conventional chain or suitable speed to advance sheet 60 at a constant speed. The movement of sheet 60 may be continuous if the press carriage 56 is controlled in its movement to move at the same speed as 60 for a short distance while the bed member 55 is advanced and bonding or welding is being effected. Between the bases of the containers 20 held thereby and the sheet 60. The means for driving sheet 60 may also be intermittently operated and interlocked in its operation to cause a predetermined length thereof to remain stationary over 61 while one or more rows of the cups 20 are prepositioned over said length or portion thereof and are welded or bonded thereto.

The sheet 60 is adapted to be guided past an automatic machine 64 for filling or placing predetermined quantities of material or articles in respective of the containers 20 through chutes 65 or other means extending over respective lanes of the sheet 60. The release of material from machine 64 may be effected by means of valves or the like operated by solenoids or motors which are interlocked in their operation to the movement of the sheet 60 or are synchronized or otherwise controlled to release said material(s) at predetermined times during the cycle. The notation 66 refers to a plurality of belt conveyors which may be kept loaded by conventional means, the movement of each of which may be controlled to automatically effect the deposition of material or objects into respective of the chutes 65 for loading into respective of the containers. Various known designs for intermittently operating filling apparatus may be employed for the loading machine 64.

The belt or sheet 60 continued its movement beyond 64 wherever the contents of the containers 20 may be further processed by heating, refrigerating or the addition of other materials thereto. The contents of the containers may be baked or otherwise cooked, frozen or otherwise treated by any one or a combination of the above.

At is end, belt 60 with the filled containers thereon passes through a cutting machine 67 which is operative to cut 60 into predetermined lengths 60' which may individually and automatically be loaded into cartons 68 which pass in front of 67 on a belt conveyor 69. The movement of the belt 63' of the conveyor 69 may be intermittent and synchronized to the operation of 60 so that one or more lengths 60' of the cup mounted base 60 will be deposited in each container.

The notation 71 refers to a machine for further operating on the container and/or product therein. For example, the container 68 may be closed or capped in 71, stacked or cartoned.

The operation of the servo-motors driving the sheets 51 and 60, those advancing and retracting 55 and 56, the servos releasing or delivering predetermined quantities of material or objects from the shearing or rotary cutting mechanism 67 and the movement of the belt 63' of the conveyor 69 may be controlled by an automatic sequencing controller such as a self-recycling multi-circuit timer or any other control means of known design which is preferably interlocked by limit and/or other switches to effect the mentioned fabrication and filling functions.

It is noted that the base sheet material 60 may be driven either continuously or intermittently past the filling machine 64 which action will depend on the material being conveyed thereby into the individual containers, its rate of flow from the spouts 65 and the lineal speed of 60. In other words, filling may be accomplished on the fly with 56 in motion or while 60 is momentarily stopped with respective of the sub-containers 20 prepositioned relative to respective of the filling chutes or spouts 65. The means for operating the roller drives 62, 63 may be a stepless motor or conventional electric motor having the desired acceleration and stopping characteristics. The filling spout 65 may also be adapted to move short distances back and forth along the conveyor while discharging material while the sheet 60 is in constant motion past 64 to effect said filling.

FIG. 8 illustrates schematically a system for controlling the apparatus of FIG. 8 including basic servos and controls shown in block notation. The notations 78 and 79 refer to motor drives or gear motors for respectively effecting the drive of sheet materials 51 and 59 through respective sets of roller driven 83 and 63. A linear motor or hydraulic cylinder 72 advances and retracts carriage 56 and second linear motor 75 mounted on 56 lower and raises male die-bed 55. The control apparatus will be described by reference to a cycle of operation. It is assumed that the proper power supplies are provided on the correct side of all switches and controls.

Assuming that die 55 is retracted with the containers retained by the die formations 12 thereof, and that servo 72 is operating to drive 55 to a position 55' over bed 61 and sheet 60, when shaft 72S of cylinder 72S is fully projected a limit switch 72S effects the energization of a self-recycling multi-circuit timer 73 which respectively effects the following actions during a cycle of its operation.

The timer 73 energizes the stop control 72S of linear motor 72 stopping 55 over 61. The forward drive control 72S of linear motor 75 is next energized to cause 55 to be advanced to cause the formed parts retained be removed by the male die portion 12 to be compressively engaged against the upper surface of base sheet 60 and welded or bonded thereto as described. If ultrasonic-resistance, or magnetic-resistance welding is to be effected, the timer
73 may operate a generator 74 of the necessary electrical energy when the die-block 55 is advanced, for the time necessary to energize the transducers 34 and effect said work by supplying second multi-circuit, self-restarting or repeat-cycle timer 77. The die block 55 is provided with a notching blade 55c which provides a position indicating cut-out or edge notch in sheet 60 when it advances thereagainst, which cut-out is provided in advance of the group of containers welded to 60 in the same action. A limit switch 76 is adapted with its actuator positioned to ride in or against the cut provided by 55c and, when actuated thereby, energizes the timer 77 which, at predetermined intervals, during which respective containers are beneath respective of the filling spouts 61-1 to 65-N, energizes respective solenoids 61S-1, 61S-N which operate variously permitting predetermined quantities of the materials conveyed to the chutes to pass through to the containers below.

The programmed controller 77 also effects the operation of the cut-off mechanism 67 by energizing a solenoid or series 67B to cause a blade to shear a strip 60 near end. The blade 67K may be a rotary or lineal cutter operated by 67B.

After the containers held by 55 are bonded to 60, the timer 73 energizes the reverse control 75R of servo 75 causing 75 to retract 55 leaving the cups 20 on 60. Timer 73 then energizes the forward control 79F of motor 79 which drives sheet 60 forward until 76 energizes 77 which controls 79 to stop at the proper instant by energizing the stop control 79S of 79. If it is desired to intermittently move 60, while 55 is retracted and forming new containers, to effect the filling of these containers on 60 in the area of the filling spouts, timer 77 may alternatively control 79 to start and stop the desired number of times between which actions respective of the product release controls 65S-1 to 65S-N may be energized by 77.

The forward drive control 79F of servo 79 is shown energized by timer 73 although, as stated, it may be controlled by 77. Timer 73 is operative to effect the energizing of the retract control 72R of 72 and, thereafter the advance and retract controls 75D and 75U of cylinder 75 to effect the formation of the sub-containers as well as the forward drive and stop controls 78F and 78S of motor 78 to position a new length of sheet 51 in the press for the next forming action prior to the advance of 55 thereagainst. The cycle then repeats as described with modifications to the control system of FIG. 8 which will be obvious to those skilled in the art, the packaging apparatus described hereafter may be similarly controlled.

Other features of the control system of FIG. 8 include the energization of one or more solenoid operated valves such as 16V by the multi-circuit timer controller 73 at the proper time interval in the cycle for providing a vacuum and/or pressure on lines such as 16, 17 and 17 associated with the forming dies to effect the functions heretofore described, the energizing of controls effecting the starting and stopping of motors for controlling other conveying apparatus associated with the machinery of FIG. 8 such as motor 69Y' for moving the belt 69' of conveyor 69 for feeding and prepositioning cartons such as 60 or more of the feed conveyors 66 as shown in FIG. 8 to maintain the storage and/or delivery chutes of 64 stocked or filled with material. If the forming press represented by components 54 to 57 is a compression or injection molding machine for forming the cups 20 the multi-circuit timer 73 may be utilized to control the cyclic operation of the press by controlling the movement of the mold or die components, the injection valves and the further operation as described for effecting the transfer of the molded cups to the base sheet 60. The components illustrated in FIG. 8 could essentially be applied to an injection molding of the containers 20 with the die components 54 and 55 representing respective injection mold valves, the male half 55 being used to remove the molded components from the female mold half 54 and transfer them to the sheet 60 where they may be removed from the mold portions 12 when they are bonded to 60 and/or by the use of positive air pressure applied through the lines 16 of the base 55, which pressure is controlled by timer 73 operating valve 16V, at the proper instant, which valve is in a line 16L connecting 16 with the necessary pressure system. In such a molding apparatus, the servo 78 would drive the screw of the injection mold and/or operate the inlet gate to effect the admittance of the liquid plastic into the mold at the proper time in the cycle.

FIG. 9 illustrates apparatus for fabricating cups or the like from sheet material by means of a plurality of rotating dies which replace the track mounted, flying press 55 of FIG. 8. The rotating machinery 89 consists of a base disk or drum 890 rotationally mounted on a shaft 82 which is rotationally supported by bearings (not illustrated) and is power operated. The drum is controlled by an indexing mechanism which is adapted when actuated to rotate the base 800' through a predetermined angle and to pause thereat while moving or otherwise thereon cooperatively engage the work. In FIG. 9 the tools consist of dies 83, shaped in accordance with one of the die formations illustrated in FIGS. 1 to 7 for forming cup containers from a sheet 86 of foil, plastic or laminated material supplied from one or more spools and a power drive by means of power operated friction rollers, a plurality of which 86a, 87a', and 87b, 87b' are illustrated positioned along female die member 85. A cavity 85' in the die 85 cooperates with each of the forming die portions 84 of the male dies 83 in forming the sheet 86, which cavity may also include die pads 86, 87, 88, 89 and 90 and retaining it on the nose 84 of the die as heretofore described.

Eight dies are illustrated, each of which may consist of a single die nose 84 or a row of said dies, each of which will form a respective cup when it is advanced into a respective cavity 85' in the female die block 85. Each of the dies is mounted on the shaft 81 of a respective ram 81 which may be fluid or electrically operated to advance and retract the die automatically relative to the female die 85 and a table 90 over which the sheet 88 to which the formed cups are to be secured, is driven. When retracted, each die will clear the apparatus and packaging adjacent the fixture 95.

It is noted that other apparatus or dies associated with fabricating or finishing the articles 20 may also be spaced about the apparatus 80 and interlocked in their operation with the operation of the apparatus of FIG. 9. When advanced, the die may be used to either form a cup or to effect its positioning and securing by any of the means heretofore described to a sheet of material such as 88. The die 83j is shown advanced against the sheet 86 to form it into a cup in the cavity 85j of the die 85. During the cycle of operation, die 83j retracts permitting it to clear the die 85j forming the cup 88j and advances against the sheet 88 and effects the welding or bonding of said cup to the upper surface of 88 by compressively engaging it against the press bed 90 which has a cup formed on its nose, advances against the sheet 88 and effects the welding or bonding of said cup to the upper surface of 88 by compressively engaging it against the press bed 90 in the manner heretofore described. A die 83f is shown in an act of securing a cup to the upper surface of 88 after which it retracts so that the fixture may be indexed to the next position. The movement of the sheet of foil or laminated material 88 is controlled by the intermittent rotation of the upper and lower groups of power operated rollers referred to respectively by the notations 89 and 89 which are power operated by servo motors which are controlled to intermittently advance 88 predetermined distances.
such that each newly secured cup will be positioned against 88 immediately behind the cup previously secured to 88 as illustrated in FIG. 9. Suction and/or pressure may be utilized for removing the cup from the die 85 and retaining it on the nose of the male die 84 by providing respective fluid conducting means extending to each die from the central drum 80', which lines are each connected to a respective solenoid or cam operated valve, which is automatically controlled to open and close to effect said actions by known means. If fastening is effected by means of heat sealing or ultrasonic welding, the respective transducers may be secured either to the head 84 or the correction portion of the press bed 90, the action of which is automatically controlled and synchronized to the intermittent movement of the sheet 88 and the operation of the fixture 80.

For certain packaging functions a plurality of differently shaped dies provided in the positions of the illustrated die-heads 83a to 83h may be provided on the packaging fixture 80, which dies may be selectively positioned relative to a plurality of female dies of which 85 would be one and selectively positioned relative to the table or press bed 90 for providing different shaped containers on the sheet 88 in any predetermined array or order. Apparatus of this type is extremely flexible in that, if it is desired to shift from one packaging or assembly arrangement, said action may be accomplished with respect to each of which the rotation of the wheel or drum 80 the action of which is interlocked to the radial movement of respective of the dies. Thus, depending on the particular sequence of the programming means, any array of sub-containers may be provided in any order or spacing on sheet 88 provided that if the movement of 88 is synchronized to the operation of the rest of the apparatus. These functions may be effected by means of a multi-circuit, repeat cycle timer which controls solenoids effecting the operation of the servos for indexing the wheel or drum 80, operating the rams or linear motors 81 and operating the drive wheels 89 and 89'.

It is further noted that the containers 20 may also be automatically filled by the apparatus of FIG. 9 after being welded or bonded to the sheet 88 if a flowable material is introduced through each die nose 83 into each container during its retraction away from the container after it has fully retracted and clears the container. If the sheet 88 is guided in a radial path around the perimeter of the fixture 80, the bonding or welding and filling of the individual containers may be accomplished on the fly without stopping the movement of the package.

In the assemblies and package constructions of FIGS. 1 to 9 which provide limited area welding or bonding between surfaces to effect the temporary securing of the components, the various techniques of spot welding or the like have been proposed as having means for effecting spot welding or the like have been proposed as having means for effecting spot adhesive bonds therebetween. Adhesive bonding may be effected by the provision of an applying machine for automatically printing or otherwise applying spot areas or drops of suitable adhesive to the container base 86, or both the container and the base sheet 86. If the adhesive is of the self-drying type, the surfaces to be bonded must necessarily be abutted and compressed together shortly after the application of the adhesive. If a pressure sensitive non-drying adhesive is used it may be applied whether just prior to assembly of the die members or at some time prior to the assembly operation, for example, before the base sheet must be synchronized to the movement of the means for applying the containers thereon or photoelectric scanning means may be used to detect the containers and control the operation of cylinders or rams.

The use of a heat sealable plastic may be used per se for the base sheet or coated as a thin film on either or both surfaces of the base sheet or coated on predetermined spot or band areas of the base sheet. Heat sealable plastic, such as Videne A, a vinyl chloride, may be coated on the base sheet as a series of parallel longitudinally or laterally extending bands on the base sheet, or as spots of limited areas of said plastic which will effect the conservation of said plastic since only a small area or patch of said plastic film is required, or a spot weld with the base of the container. The spots or bands of said plastic may be applied prior to coiling the base sheet. The movement of the base sheet past the dies used to effect the spot welds will necessarily be synchronized to the operation and movement of said dies, which synchronization may be effected by means of position indicating marks or cutouts provided at spaced intervals in 86 and a detection relay such as a photoelectric cell adapted to actuate cylinders 81.

FIGS. 10 and 11 illustrate a modified form of the die apparatus of FIG. 8 which permits the formation of a plurality of cup shaped containers from a single sheet of material and the securing of said containers to a base sheet in closer proximity than that in which they were formed. If a plurality of shapes or containers as described are formed from a single sheet of material, they must necessarily be spaced sufficiently far apart to provide enough material for fabricating each container. Since the metal or plastic is drawn or forced into the cavity of a mold, there must be sufficient sheet material beyond the perimeter of the cavity from which the container may be shaped as shown in FIG. 10 and 11. Each of which is shown advanced into a respective cavity of the group 85a to 85c of the female container forming die 91.

As formed, each container is thus positioned apart from the other and in certain packaging structures, such as the boxing of candy, it may be desirable to position the containers closer together. In FIG. 11, the dies have been moved close to each other whereby the walls of each abut each other so that the respective containers 20a, 20b, and 20c are positioned closer to each other than when they were formed. The apparatus may include means for moving the dies or die portions 84a and 84c towards the central die portion 84b just prior to positioning said dies with the containers thereon in abutment with the sheet 88 which is shown resting on the die or press plate 17'. Welding or bonding may be effected by any of the heretofore described processes whereafter the die portions are adapted to automatically lift out of the respective containers leaving them on sheet 86 and thereafter automatically spread apart as in FIG. 10 and position over the forming die 91.

FIGS. 12 and 13 illustrate sheet forming and bonding apparatus 92 adapted to perform essentially the function of the apparatus of FIG. 9 without the need for said plurality of linear actuators or hydraulic cylinders 81 as described. The sequence of operations during a single forming and bonding cycle are illustrated in FIGS. 12 to 14 and further details of the simplified form of said apparatus are illustrated in FIGS. 15 and 16. In FIG. 12 a plurality of forming and welding dies, referred to by the notations 94a to 94d, are shown secured to the surface of a disc or drum having a heavy casing 92', the assembly being rotatable on a shaft 93 and adapted to index in each position from forming to forming. The apparatus 92 includes means for linearly moving said base 92' towards a die-forming platen or bed 85 to engage with sheet material 86 driven thereacross and to shape said material as heretofore described into cup-shaped containers whereafter the former prior to the assembly of die 94a is adapted to retract and move towards a second sheet 86 of material material which is previously formed container such as 20b which is compressed and bonded or welded to the upper surface thereof by one of the methods described. Power operative rollers drive the sheet 86 across a platen 90. A single cycle of operation comprises the advancement of base 92' towards bed 85 in a manner to form a cup on the upper male die portion 94a, the retraction of base 92' from 85 with the cup thereon and the further advancement of 92' with a container formed on diametrically opposite die 94c until said
container engages the upper surface of the sheet as illustrated in FIG. 14. After the container is welded or adhesively bonded to sheet 88 the base 92 moves upward a sufficient distance for die portion 94c to clear the cup 20c which it had just formed. A new cup is thus formed while the sheet 88 is advanced so that the last formed cup 20c to be welded thereon will clear the next die to be advanced by the movement of 92 towards the sheet 88.

The apparatus of FIGS. 12 to 14 may comprise an elongated drum as illustrated in FIGS. 15 and 16 which has respective rows of said frusto-conical die portions secured thereto each of which will form a respective cup. The drum 92 is mounted on a shaft 93 which is rotationally supported by a bearing 95 which is secured to the end cross members 95c and 95d of a frame 95 or rigid beam.

A power operated indexing mechanism 92" is secured to the frame inside the bearing 95c and is operative to cause the drum or base 95 to rotate 90 degrees each time it indexes. The frame 95 and die drum 92 is moved up and down to engage respective die portions in the cavities of the upper die block 85 and secure the cups formed by a prior operation, onto the surface of sheet material 88 which is driven over the base plate 90 as described. The lineal motion of the frame and die is effected in FIGS. 15 and 16 by means of eight fluid cylinders referred to by the notations 96a to 96b. The bottom four cylinders are controlled to operate simultaneously to advance and retract the frame to the upper four cylinders. In FIGS. 17 and 18 the dies have been reversed, that is, the stationary die block of the apparatus which may be designed as heretofore described, is replaced by a die block 97 having a protruding male nose 97e and the movable or rotating die is replaced by a die portion 99a having a cavity 99f therein adapted to the shape of the male die portion 97g of 97. Since the sheet 86 cannot be provided in direct abutment with the stationary die 97a, it is driven in close proximity to the extreme portions of the male die protrusions 97f and when the movable die 99 is advanced by movement of its base or drum 98 towards the material of sheet 88 it is shaped into a container or open shell by forcing it over the nose portion 97a. A circular cutting die 13 circumscibes nose 97a and cooperates with an annular surface of 99 to cut the sheet 86 around the flange of the shaped container portion 20a. The base 98 then retracts and the die shaped member 20a remains in the cavity 99a of 99 either by friction or by suction pressure applied to one or more ducts 56, which extend to the surface of the cavity in 99 against which the wall of cup abuts after its is formed. Eventually the die 99 is positioned over the base sheet 88 riding against the plate 90. Objects or products to be packaged, referred to by the notation 100, are automatically placed on the surface of sheet 88 as in FIG. 18 and are carried therewith immediately below the die base 98 by the intermittent motion of 88 and are totally enclosed in a pocket or package, one wall of which comprises material of 88 and the other walls of which comprise the cup shaped container 20a and the rim 20b of which is abutted against the upper surface of sheet 88 and welded thereto by one of the heretofore described methods. The base 98 then retracts after which the sheet 88 is advanced with the next product in alignment with 98 followed by a rotation of base 98 and the indexing thereof to position the next die 99 in all relative position 97g after which the described cycle repeats. Sheet 88 may be guided tangent to the circular array of dies if cups are cut or circumferentially with respect thereto if individual cups are not secured.

In a further embodiment, it is noted that the die-members 99 may each be provided with a cutting die 13a as shown in FIG. 18 which may be operative to perform either or both of two functions. The cutting die portion 13a may be used to coat with die 13a or act per se in severing the formation 20a from sheet 86 from which said formation is shaped. It may also be utilized, when advanced against sheet 88 to perforate or sever said sheet into sections defined by said cutting die which sections will include the product 100, the covering or encompassing means 20c therefore and that section of 88 to which 20c is attached or welded. The assembly so described may comprise a unit package to be packaged in the product per se or further packaged in a master carton.

It is also noted that cutting dies in the form of linear knife blades may be provided to severe or perforate pre-determined lengths of sheet 88 which lengths each contain a plurality of the formations 20a in side-by-side array. Such blades or dies may be secured directly to the base or drum 92 of the apparatus of FIGS. 12 to 16 extending the width of the sheet 88.

The apparatus illustrated in FIGS. 10 and 11 may be modified and used to retain and transfer preformed containers or cups from a supply thereof to a sheet or against the wall of a container such as a box in an automatic transfer device or assembly. The transfer members designated 84a, 84b, 84c, etc., may be provided with passageways such as 16 of the male die 10 in FIG. 1 for retaining said preformed containers on each and/or for supplying fluid or fluid material to fill each cup as or after it is transferred and positioned on a base or sheet as illustrated in FIG. 11.

The apparatus illustrated in FIG. 17 may be utilized to form and fill pockets or indented formations in sheet material. The member 99 may be similar in design to member 17 of FIG. 1 and may be provided with one or more passageways such as 16 therein which extend from a vacuum forming pump for drawing the sheet into the cavity with or without the assistance of male die 97d which may also be used as a filling spout per se adapted to be fed material through passageway 16 for at least partly filling the formation or indented sheet portion retained in the female die or cavity of 99.

Numerous other modifications of the present invention will be appreciated by those skilled in the art and accordingly the appended claims should be construed broadly as is consistent with the appended claims and in certain instances, some features of the invention will be used without a corresponding use of other features.

I claim:

1. Apparatus for forming and filling containers comprising in combination:
   (a) cooperating male and female die forming means including at least two die members cooperating to form a container to final shape,
   (b) means for feeding formable material to said die means and die forming same into the shape of a container between said die means,
   (c) one of said die forming means having a male die portion operative to form at least a portion of the inside wall of said container to shape and having a fluid passageway terminating in alignment with said formed inside wall of said container, and means for supplying fluid material to said passageway,
   (d) valving means for controlling fluid material to said passageway to fill said container,
   (e) and means operative after a container is formed by said die means and said male die is at least partly removed from the container to activate said valving means to admit a predetermined quantity of material to said container.

2. Apparatus for forming and filling containers comprising in combination with sheet forming means, means for feeding a thin sheet of deformable material to said forming means, said sheet forming means having means
for deforming said sheet into the shape of a self-supporting container, including a first die having a male portion adapted to cooperate in forming the inside of said container and further die means cooperating with said first die and shaped for forming the outside of said container, said first die having a passageway therein with a downward opening for dispensing a fluent material into the container so formed, a source of fluent material communicating with said passageway, a valving means positioned for regulating the flow of said fluent material, means for operating said valving means, means for controlling the movement of said sheet and said dies to form a container portion of said sheet and the operation of said valving means in sequence to dispense a predetermined quantity of said fluent material into said container portion immediately after its formation, and die cutting means including cooperating die means associated with said first and said further die means for severing the container portion formed from said thin sheet from the remainder of the sheet during the same stroke in which said container is formed.

3. Sheet forming apparatus comprising in combination, means feeding a sheet of thin deformable material, sheet deforming means including a rotationally mounted base, means for rotating said base, a plurality of sheet forming dies supported by said base in a circular array and each having an outwardly facing cavity, means for guiding said sheet material across the face of a cavity of a female die, a male die having a die nose and movable towards and away from said female dies to engage and deform said sheet, and means advancing said male die to deform said sheet into a cavity in a female die in synchronization with the rotation of said base when a sheet forming die is aligned therewith.

4. Sheet forming apparatus comprising in combination, means feeding a sheet of thin deformable material, sheet deforming means including a rotationally mounted base, means for rotating said base, a plurality of sheet forming first dies supported by said base in a circular array, a second die movable towards and away from said first dies, means for moving sheet material across the face of at least one of said first dies at substantially the speed at which said first dies are rotated on said base, and means for advancing said second die to deform said sheet in cooperation with said first die when a first die is aligned therewith.

5. Sheet forming apparatus comprising in combination, means feeding a sheet of thin deformable material, sheet deforming means including a rotationally mounted base, means for rotating said base, a plurality of sheet forming first dies supported by said base in a circular array, a second die having a die nose movable towards and away from said female dies, means for moving sheet material across the face of a first die at substantially the speed at which said first dies are rotated on said base, and a cutting die surrounding the nose of said second die, said cutting die being operative to shear the deformed portion of the sheet from the rest of the sheet upon movement of said second die against one of said first dies after deformation of said sheet thereagainst.

6. Apparatus in accordance with claim 5, including means for retaining the deformed portion of the sheet against said die nose after said deformed portion has been cut from the remainder of the sheet and for moving said deformed die away from said base to transfer the deformed portion of said sheet held on said nose from said female dies.

7. A method of forming articles from thermoplastic sheet material comprising the steps of providing a sheet of thermoplastic material at a temperature such that it may be readily vacuum formed, deforming said sheet into a first portion of said sheet into a cavity of a mold by means including the application of vacuum to the mold cavity and causing said sheet to conform to the shape of the wall of said cavity while retaining the remaining portion of said sheet against the wall of the mold surrounding said cavity, cutting the portion of the sheet deformed in said cavity from the rest of the sheet by shearing the sheet exterior of the cavity against the wall of the mold, and ejecting the product from the mold by applying sufficient positive pressure to the mold cavity to force the article out of said cavity.

8. Sheet forming apparatus comprising in combination, means feeding a sheet of thin deformable material, sheet deforming means including plural dies operative for engaging said sheet between pairs of said dies for die forming same to shape, a rotationally mounted base, means for rotating said base, plural dies including a plurality of sheet forming first female dies supported by said base in a circular array, male dies being movable towards and away from said female dies, means for feeding sheet material between said male dies and said base, and means for advancing said male die to deform said sheet in cooperation with a female die when said female die is aligned therewith, whereby tandem portions of said sheet material are die formed by said male die cooperating with respective female dies as they are rotated by said base and each come into alignment with said male die.

9. Apparatus in accordance with claim 8, including cooperating die cutting means associated with said pairs of dies for severing said die formed portions of said sheet from the remainder of the sheet as the base is rotated for defining individual formed articles of the severed die formed material.

10. A method of forming and feeding containers comprising the steps of feeding a first sheet of material to a forming means including a female die and shaping said first sheet by forming it against the wall of the cavity of said female die to define a first portion of a container which first portion is open at one end and has a flange portion surrounding said opening thereof, retaining said first container portion against said female die, feeding a second sheet of material adjacent the cavity of said female die, disposing a product to be packaged onto said second sheet facing said cavity of said female die and aligning said product with the open end of said first portion of said container and abutting and securing said flange portion of said container portion of said first sheet to said second sheet to contain said product between said first portion of said container and said second sheet.

11. Sheet forming apparatus comprising in combination, means for feeding a sheet of thin deformable material, sheet deforming means including a rotationally mounted base, means for rotating said base, a plurality of sheet forming male dies supported by said base in a circular array, female dies means having a cavity and supported adjacent said rotationally mounted base, means for supporting sheet material between said base and said female dies, and means for moving said base to advance a male die thereof to deform said sheet against said female dies means when said male die is aligned with said female dies means.

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