Feb. 2, 1960 A. E. COMSTOCK 2,923,654

APPARATUS AND METHOD FOR FORMING APERTURES IN MOLDED PULP ARTICLES

Filed Jan. 6, 1955 4 Sheets-Sheet 1

Fig. 1

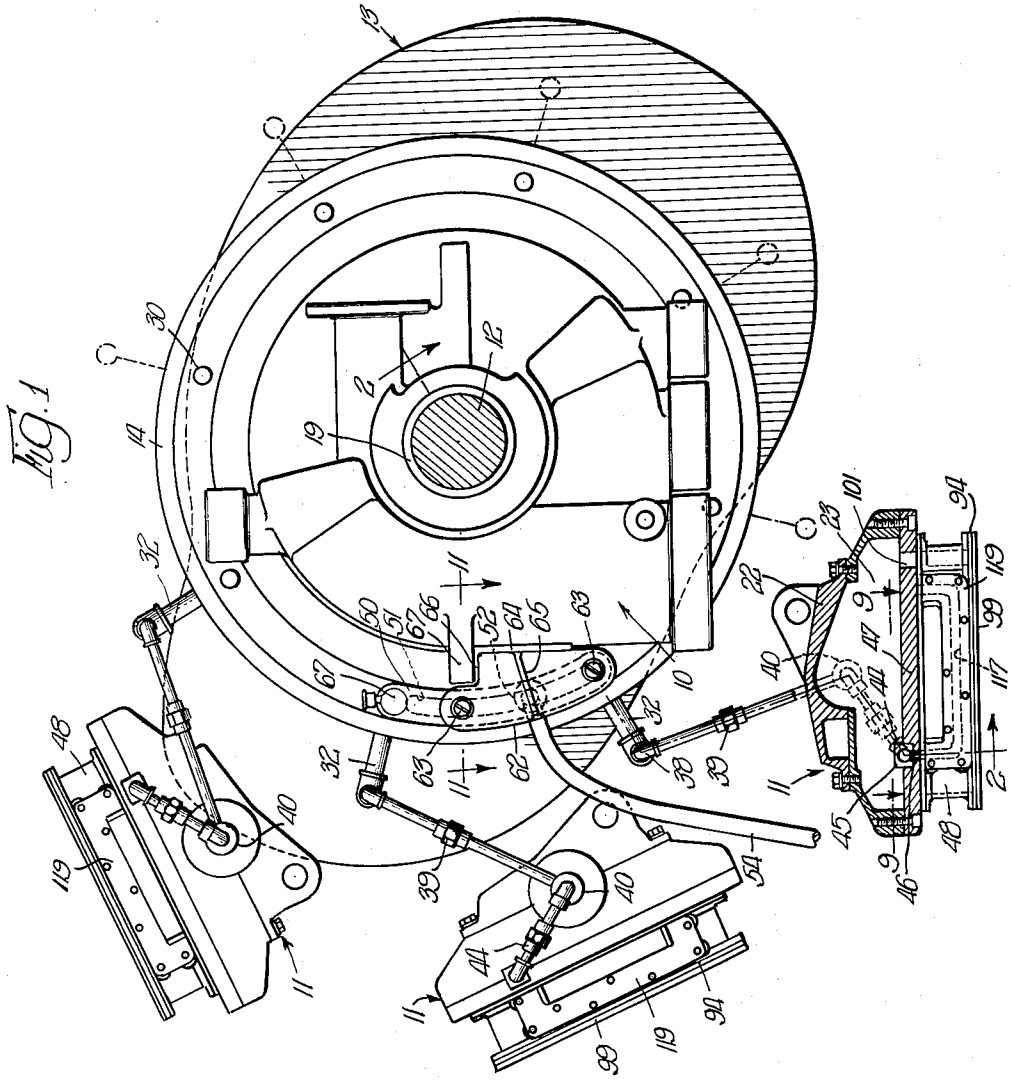
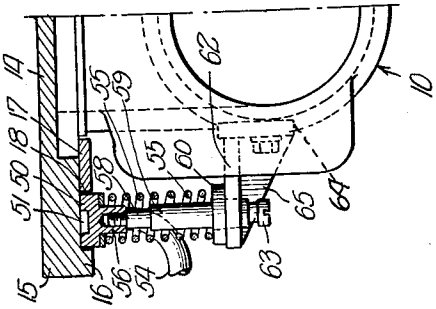


Fig. 11



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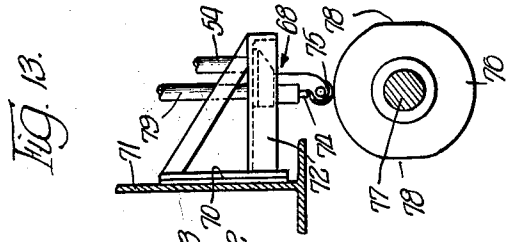


Fig. 13.

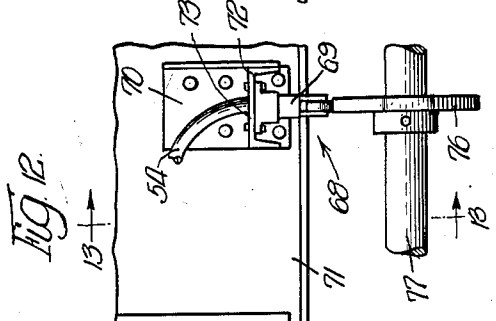


Fig. 12.

Fig. 2.

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APPARATUS AND METHOD FOR FORMING APERTURES IN MOLDED PULP ARTICLES

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Fig. 3.

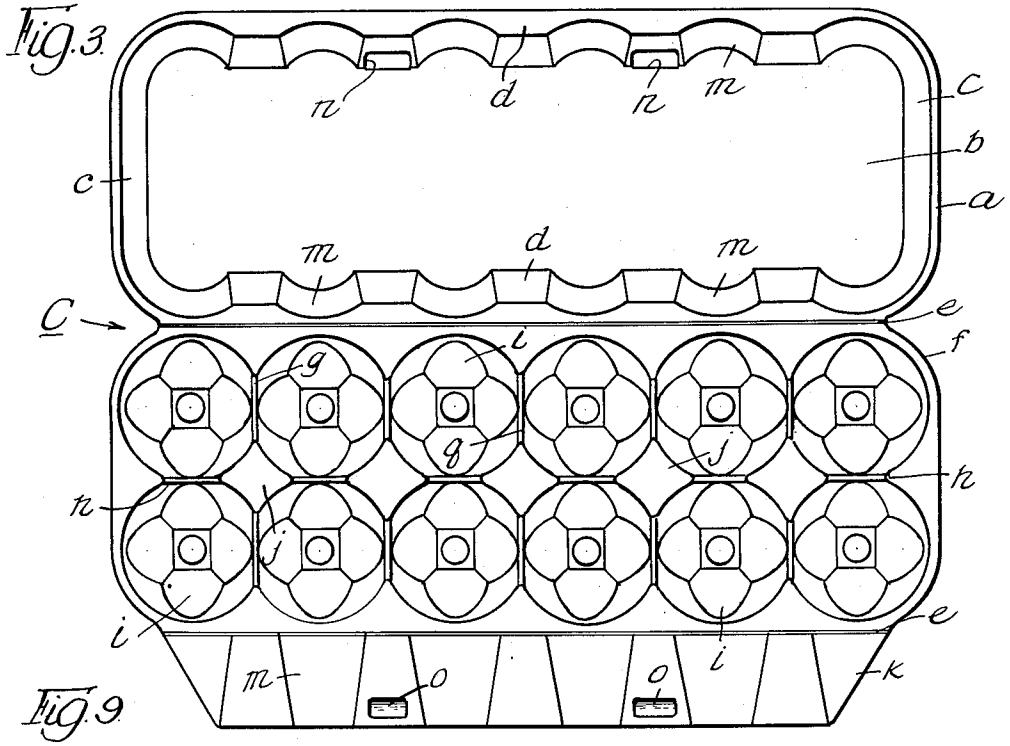


Fig. 9

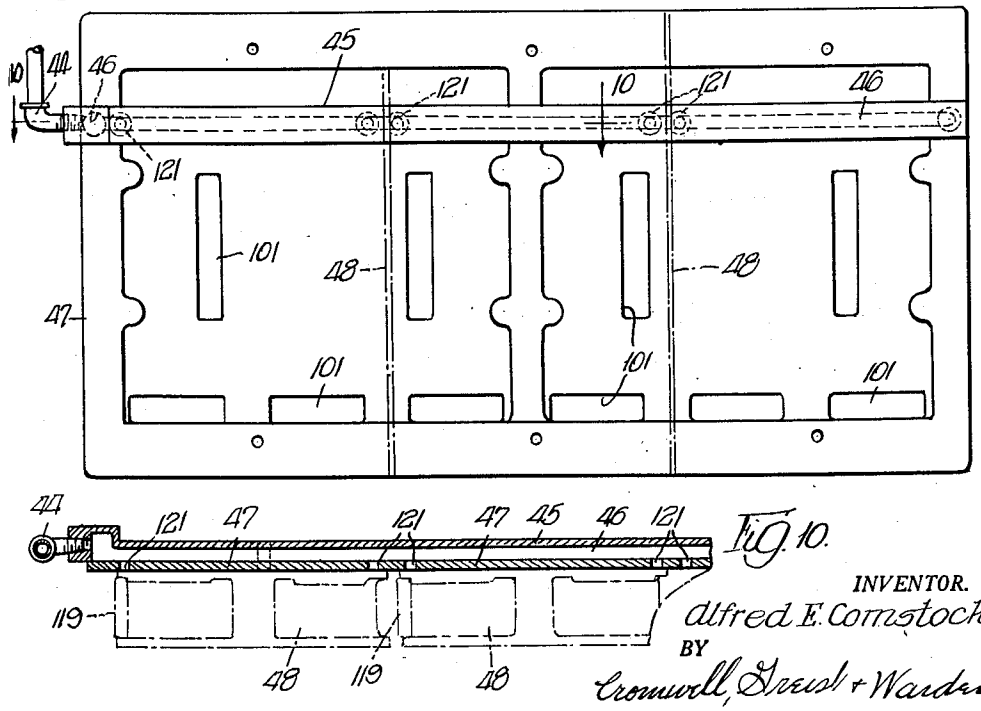


Fig. 10.

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APPARATUS AND METHOD FOR FORMING APERTURES IN MOLDED PULP ARTICLES

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Fig. 4

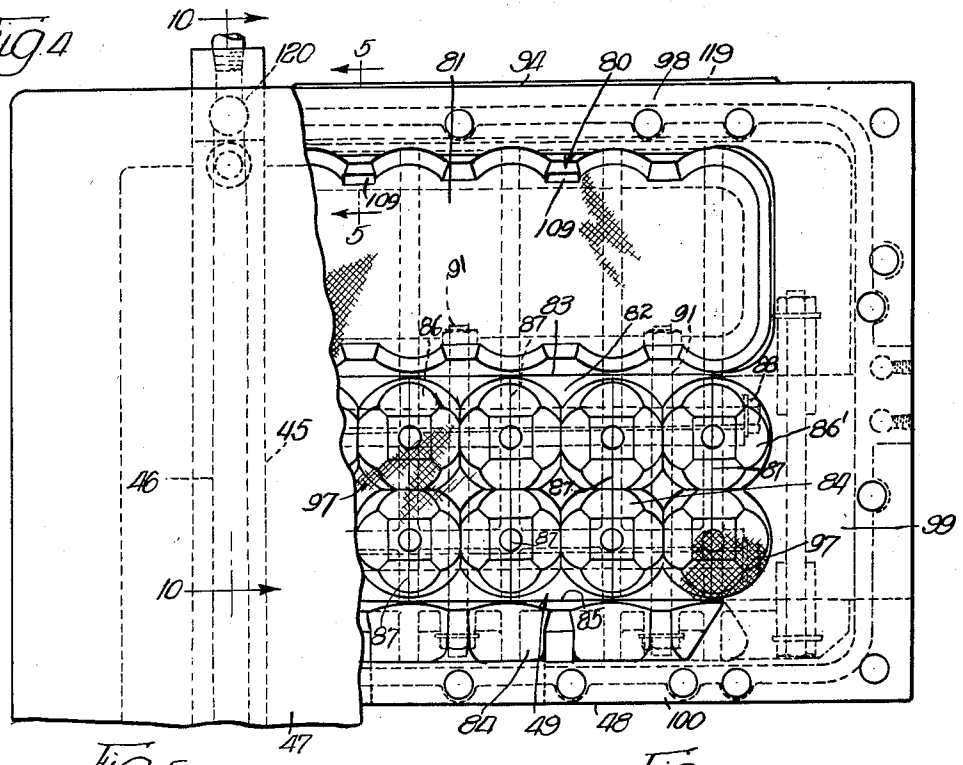


Fig. 5

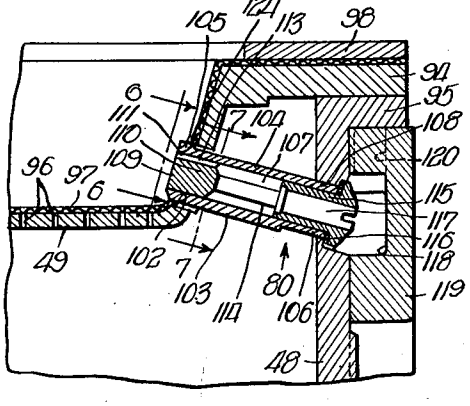


Fig. 6

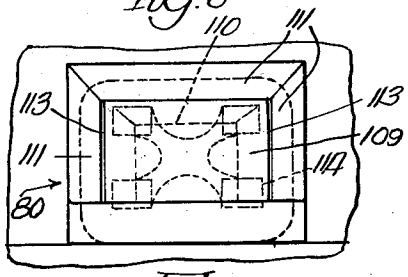


Fig. 7

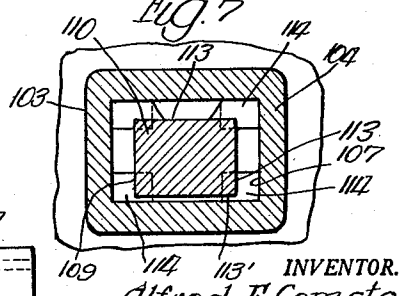


Fig. 8A

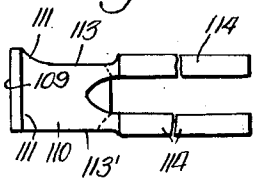
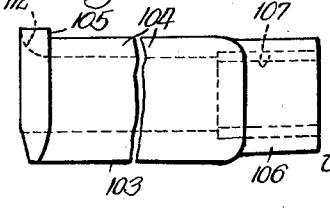


Fig. 8B



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United States Patent Office 2,923,654 Patented Feb. 2, 1960

2,923,654

APPARATUS AND METHOD FOR FORMING APERTURES IN MOLDED PULP ARTICLES

Alfred E. Comstock, Palmer, Mass., assignor, by mesne assignments, to Diamond National Corporation, a corporation of Delaware

Application January 6, 1955, Serial No. 480,193

14 Claims. (Cl. 162—228)

The present invention relates to improvements in a continuously acting apparatus by which special molded pulp cartons and like objects are formed. In accordance with the known practice, this is done by the deposition on a shaped, mesh-like or foraminated screen of a felted layer of wet pulp fibers, which are drawn onto the surface of the screen by suction applied to the opposite side thereof. Continuous rotary apparatus of this general type is commonly employed in the manufacture of molded pulp egg cartons, an example of which is shown in the patent to J. W. Cox No. 2,529,140 of November 7, 1950.

The present improvement deals with apparatus capable of forming apertures in a surface of one of the component sections of such a carton as an incident of the molding operation, and as such deals particularly with equipment for the formation of a lock type carton which is a refinement of the molded carton of the Cox patent. An example of apertures in a surface of a component section of a carton is illustrated in the patent to Koppelman No. 2,093,280, of September 14, 1937.

While the Cox and Koppelman cartons differ materially in their functional attributes, it may be assumed that the improvement of the invention has applicability in common to the molding of all thereof. In this, the formation of an improved locking aperture or apertures in a molded pulp article, involving an air jetting operation during the actual wet molding procedure, is the common objective. This aperturing constitutes a part of the locking provisions of a carton by which its cover and bottom sections are releasably locked together.

It is an important feature of the improved appartus that it operates during the molding cycle in such fashion as not to slow down the output capacity of a conventional molding machine in any degree. Nor does it detract in any way from the quality of the molded article, as a whole, while vastly improving the character of the desired aperture, in respect to the cleanness of definition of its margins, over what has heretofore been attainable by any molding equipment or procedure. This is accomplished in spite of the inherent tendency of the wet fibers to deposit and build up about the periphery of an imperforate plug commonly used in the molding of apertures, or onto any imperforate surface incorporated in a molding or forming die, with a resultant rough, feathered or deckle edge effect in the completed article. Since edge surfaces of this character are inconsistent with the intended locking action of the Reifers type carton, as hereinafter fully described by reference to the drawings, the elimination thereof is an essential object of the present improvement.

The basic molding apparatus, as generally shown herein, is a continuously acting rotary pulp molding machine. Molding forms or dies, characterized by a stably supported, mesh-like or foraminate screen surface shaped in the outline of the desired article, are mounted on appropriate die holders, which are in turn mounted in aligned sets on molding heads or boxes carried by radially extending arms or like supports of the machine. So

mounted, the forms are caused to travel in immersed relation to a supply of a watery slurry of pulp fibers contained in a stationary tank.

Suction is applied to the unexposed side of the forms as their screens pass through this slurry, which causes the fibers to be deposited and felted in a substantially uniform layer on the exposed surface of the screen. Upon emerging from the slurry a phase ensues in which an air pressure jetting is performed on the wet layer adjacent the areas of the rough apertures resulting from non-deposition of fibers, and it is with this operational phase that the invention deals. The wet molded and properly apertured articles are then transferred by suction, positive air pressure, or a combination of these, onto drying forms, by which they are carried through a drying oven and thoroughly dried.

Air jetting as mentioned above comes into play at the instant the face of the molding screen at the aperture area comes clear of the slurry, for if the action is retarded it does not fully avoid a deckle effect at the aperture edge in question, while if premature, an undue thinning of the pulp material around the aperture results. As the jetting is best performed, a sharp definition of the aperture is obtained due to the application of an air jet stream in a carefully determined annular pattern, and one or the other of the disturbing phenomena will arise if the timing is not correct.

Specifically considered, and as distinguished from prior practice in which molded apertures are produced by the simple plugging, or otherwise rendering impermeable to fluid, of a predetermined area of a molding screen, hence making that area incapable of having fibers deposited thereon, plugging in accordance with the present improvement is accomplished by a special hole forming jet assembly, supplied with air under pressure in a special manner. The jet assembly is made up of a tubular jet shell, fixedly applied in relation to the molding form and foraminate screen in an aperture thereof which corresponds with the cross sectional outline of the shell. The shell is appropriately secured in place in this relation both to the form or die and to a rigid die holder, which mounts the die and constitutes an individual suction box for the same as in prior practice. The interior of the shell is communicated, at its outer, rear or die holder end, with an air pressure manifold.

A specially shaped jet core is fixedly, though removably, held by friction in the interior of the jet shell, being spaced a trifle from the latter at its sides to afford restricted orifices of special design. Through these orifices air jets are properly directed to shape the margin of the aperture left at the face of the core in the desired clean-cut fashion. The improved core is of a hound's tooth design, having spaced rearwardly extending prongs adapting the same for tight frictional engagement with the interior of the shell, so as to maintain it in place without likelihood of being dislodged in normal operation. The prongs additionally serve in conjunction with the main body portion of the core, and in conjunction with the jet shell, in controlling the flow of the air jet to and through the orifices. The core is removable for inspection, cleaning or replacement, if desired.

The rear of the improved jet assembly, as thus generally described, opens to the interior of a transversely arranged air pressure manifold, which extends along one side of each die holder for an article forming die. A number of such die holders, three in the illustrated installation, are rigidly mounted in a conventional way on a heavy flat die platen, through openings in which suction is communicated to the rear of the forming die, as in the conventional molding procedure. The respective pressure manifolds are supplied, at the jetting phase of the molding cycle, with air under pressure from a longitudinally

extending, elongated pressure header servicing all the die holders on the platen, the header being rigidly applied to the rear of the platen and being communicated with the respective manifolds through appropriate apertures in the platen. These are, of course, in addition to and quite separate from its conventional suction openings referred to above. Each of the platens on the respective rotary molding heads of the apparatus thus services a plurality of die holders and forming dies as the same emerge from the pulp slurry.

Since the forming heads are, in accordance with the apparatus of the above identified Cox application, swiveled on radially extending supports, this swiveled mounting entails the use of a rotatable type of joint for an air pressure line supplying the longitudinal pressure headers; and since the rotary structure as a whole is pressure supplied from a stationary source, the individual air pressure lines to the respective rotating heads are each connected in sealed relation to a rotary distributor disk on the main axis of the machine. This disk has axially sealed, sliding engagement with an arcuate distributor valve which is received in an annular groove in a face of the distributor disk, being spring urged against the latter to avoid pressure loss at the sliding joint. Air is applied to this distributor valve from a pressure line controlled by an intermittently acting, cam-controlled, automatic valve, which operates to initiate and terminate an air jetting phase in properly timed relation to the molding phase.

Through the agency of pressure jetting and timing instrumentalities of the general character referred to, each of the molding heads is subjected to air jetting exactly at the conclusion of fiber deposition, and no diminution of speed of operation of the machine is required. Moreover, the provisions are such that the timing of jetting cycles is accurate and foolproof for each of the several individual suction molding heads. Considering the extremely flimsy character of the wet, relatively thin layer of pulp fibers on which the hole-defining jetting operation is carried out, it will be appreciated that a probelm of the most serious sort is presented in regard to the preservation of the fibers directly adjacent the desired opening in a properly distributed layer of uniform depth, yet with a sharply cut off margin at the opening, as distinguished from a rough or deckle edge. Both the automatic timing provisions and specific structural features of the individual jet assemblies are notable for their success in meeting this problem, particularly at the relatively high speed at which the apparatus performs the operations referred to above.

The foregoing statements are indicative in a general way of the nature of the invention. Other and more specific objects will be apparent to those skilled in the art, upon a full understanding of the construction and operation of the improvement.

A single embodiment of the invention is presented herein for purpose of illustration. It will be appreciated that the invention may be incorporated in other modified forms coming equally within the scope of the appended claims.

In the drawings:

Fig. 1 is a fragmentary view partially in end elevation which is more or less schematic in character, insofar as the molding machine structure as a whole is concerned, a portion of the view being shown in transverse vertical section through a molding head of the machine to show the improved features of the invention in a general way;

Fig. 2 is a view in irregular or discontinuous section along the general line of the jet air pressure supply to a molding unit of the apparatus, i.e., approximately along line 2—2 of Fig. 1, the view being otherwise broken away and sectioned to illustrate further specific details;

Fig. 3 is a top plan view of a molded pulp carton formed by the apparatus, the carton being shown open and upwardly exposed to view;

Fig. 4 is a fragmentary plan view, partially broken away, illustrating a portion of a platen, die holder and die unit of the apparatus, in which one aspect of the improvement is presented, showing the same in relation to a pressure distribution header of the jet supply line;

Fig. 5 is an enlarged fragmentary view in transverse vertical section along a line corresponding to line 5—5 of Fig. 4, generally illustrating features of an improved jet assembly;

Figs. 6 and 7 are, respectively, enlarged fragmentary views in cross section along lines 6—6 and 7—7 of Fig. 5, further showing the relationship of component parts of the jet assembly;

Figs. 8A and 8B are, respectively, views in side elevation of the jet core and jet shell of the assembly in question;

Fig. 9 is a rear plan view of a die-box platen and pressure distribution header assembly otherwise depicted in Fig. 4, this view being approximately from line 9—9 of Figs. 1 and 2;

Fig. 10 is a fragmentary sectional view, approximately along line 10—10 of Figs. 4 and 9, further illustrating the construction of the distributor header referred to, as well as its relation to the platen and die holders of the molding head, the holders being indicated in dot-dash line;

Fig. 11 is a fragmentary view in horizontal section along line 11—11 of Fig. 1, illustrating details of a pressure distribuiton sliding valve subassembly of the apparatus;

Fig. 12 is a fragmentary side elevational view of a master air pressure valve control unit of the apparatus and the provisions for mounting the same; and

Fig. 13 is a view in transverse vertical section along line 13—13 of Fig. 12.

Reference should first be made to Figs. 1 and 2 for a general showing of the structural features of the improvement as they are related to suction pulp molding equipment such as is illustrated and described in a copending application of John W. Cox, Serial No. 266,729, identified above. In this connection, reference may also be had to Fig. 3 of the present drawings for an illustration of the type of molded pulp carton, further shown and described in the above identified Reifers application, which the present improvements are instrumental in forming.

The reference numeral 10 generally designates a heavy cast or welded framework of the apparatus, this framework and associated parts having appropriate provisions, of no bearing on the present invention, for the communication of a vacuum with suction boxes of the several individual molding heads of the apparatus. These are generally designated 11. Framework 10 provides a bearing for a longitudinally extending main drive shaft 12 of the apparatus, and a large fixed control cam 13, governing compound movements of the heads 11 in operation, is suitably supported on the frame. The cam is shown only to the extent of its general over-all outline, since its details and function in regard to controlling the movements of heads 11 may all be as illustrated in the Cox application and, as such, form no part of the present invention. It may be assumed that these heads are appropriately supported, as by the rotary spider means of that application, and that they are controlled by suitable cam followers engaging cam 13, also in the fashion shown in said application.

Main drive shaft 12 has fixedly mounted thereon a pressure distributor disk 14 of relatively large diameter, the outer periphery of the disk being thickened at 15 and provided with an axially extending peripheral flange 16; and an annular internal ring 17 coacts with flange 16 in defining an axially opening annular groove 18 facing outwardly of the disk. A hollow tubular hub 19 is keyed to rotate with shaft 12, and this hub carries a plurality of radiating chambered housings 20 on which vacuum heads 11 are swiveled, through which vacuum is communicated with the interior of each head during

the molding cycle. Reverse positive pressure (other than hole jetting pressure) may also be transmitted through these spaces during a transfer phase in which the molded article is shifted onto a drying form. Since the special provisions in regard to suction passage means and to the mounting of the molding heads do not constitute part of the invention, a brief and generalized description thereof will suffice.

Each head comprises a suction box **22** bolted to a housing **20** and defining in part an internal suction chamber **23**, a hollow, radially extending neck **24** of the box communicating the housing with the suction chamber. A swiveled die support **25** is provided with journals **26** at opposite ends thereof which are mounted by antifriction sleeve bearings on the opposite ends of a swivel shaft **27**. Shaft **27** is suitably borne by the outer end of suction box **22**, the pivoting provisions including appropriate pressure seals at the axial meeting surfaces of the relatively moving parts, thus enabling a limited rotative movement of the support **25**, and associated parts to be described, in reference to the radially extending spider and passageway provisions. It is with the means to supply air under pressure to the pivotally mounted members that the improvements of the present invention deal, in one of its aspects, and such means will now be described.

Referring again to the pressure distribution disk **14** shown in Figs. 1 and 2, and also in Fig. 11, it is provided with a plurality of ports **30** spaced uniformly thereabout, one for each head **11**, and extending therethrough to communicate with the annular groove **18** of the disk. These ports are each tapped for the reception, from the inner side of the disk, of an individual pressure supply line of flexible character for each of the molding heads **11**.

This line comprises an **L 31** secured in port **30**, a nipple **32** leading to a branch **T 33**, from which a branch pipe **34**, as connected by a union **35** with a similar pipe **36** and a coupling **37**, extends longitudinally through the entire axial length of the molding head in question. Further assemblies of pressure supply and distribution elements are in turn associated with the **T 33** and coupling **37**, and they are identical though oppositely arranged; accordingly only one of these assemblies will be described, on the understanding that corresponding parts and relationships of the other are designated by corresponding reference numerals, primed, and have corresponding functions.

A ninety degree street **L 38** is associated with **T 33** and is placed in communication, by a line including a union **39**, with a rotatable joint **40** of well known construction. This joint permits swiveling action of the pressure supply line at suction box **22**, being piloted on the outer axial end of molding head swivel shaft **27**. The piloting provisions (Fig. 2) take the form of a sleeve bushing **42** set in the end of shaft **27**, in which a threaded stud **43** is received as a pilot to mount the joint **40** in the bushing, the stud being threadedly received by the shaft end.

A connector pipe and **L 44** communicate the fluid pressure line as so far described with an end of an elongated pressure distributor header **45** which is formed with a continuous conduit groove **46** along practically its entire length. Groove **46** opens to the outer surface of head **45** to face the rear surface of a relatively large, die-supporting platen **47** (see Figs. 1, 2, 4, 9 and 10), which platen extends across the entire axial length of each molding head **11**. It affords a mount for a group of individual, box-like die holders **48**, along with the respective forming dies **49** and associated jetting provisions with which another aspect of the invention deals, as will be hereinafter described in greater detail.

Swiveled pressure piping provisions of the above character insure that as pressure distributor disk **14** rotates in the normal operation of the molding apparatus, air under a pressure of, say, two pounds per square inch, supplied at a rate of about twenty-four cubic feet per minute, will be successively introduced into the respective lines of piping to the swiveled heads, and to the respective pressure distribution headers **45** by which it is carried across each platen **47** and admitted therethrough to the interior of the respective die holders **48**, to be applied to the forming dies **49** thereof (shown in Figs. 4 and 5), in a fashion to be later described.

Air is supplied to the distributor disk **14** by the stationary valving provisions illustrated in Figs. 1, 2 and 11. As appears in these figures, a ported valve segment **50** of arcuate outline (Fig. 1) is fitted concentrically in groove **18** of disk **14**, the valve **50** being provided with an arcuate valve chamber **51** in a flat side thereof which faces the disk. Intermediate its length, valve **50** is provided with an outwardly extending boss **52** (Figs. 1 and 2) which is drilled to provide a passage opening to chamber **51**. An air pressure supply tube or pipe **54** is tapped into the outer end of this passage.

Valve **50** is resiliently urged against distributor disk **14** by a pair of coil springs **55** (Figs. 2 and 11). These surround outwardly extending bosses **56** on the valve which are arranged in arcuately spaced relation to one another on opposite sides of passage boss **52**. As shown in Fig. 11, each boss **56** is bored and tapped to receive the threaded end of a pilot stud **58** of substantial length, and each stud is guided axially in a bushing **59** which is flanged at **60** to rearwardly abut against one end of a special mounting bracket **62**.

Bracket **62** is of generally arcuate configuration, as illustrated in Fig. 1, being provided with apertures to receive the pilot studs **58**, which are provided with slotted outer screw heads **63** on the opposite side of the bracket. Springs **55** act between the rear of valve **50** and pilot bushing flange **60** to urge the valve into the groove **18** of pressure distribution disk **14** with uniform force, which may be adjusted as desired by manipulation of stud head **63**.

As illustrated in Figs. 1 and 11, bracket **62** is provided with an integral attaching plate **64**, as to which it as braced by a triangular web **65**, the attaching plate being bolted to a suitable side surface of the framework **10**. Plate **64** carries an outwardly extending flanged wing **66** which is bolted to the underside of an integral boss **67** on frame **10**.

If desired, valve **50** may also be provided with an appropriate oil fitting **67** of conventional design, which communicates through suitable internal porting with the distributor disk groove **18**, thereby affording the lubrication necessary to keep the working surfaces of the valve **50** and disk in efficient condition.

The supply or air under pressure to valve **50** through pipe or conduit **54** is preferably further controlled by a master timing valve unit, illustrated only in Figs. 12 and 13 and generally designated by the reference numeral **68**. The valve **68** comprises a hollow valve body **69** mounted on a special bracket **70** which is bolted on an appropriate support, such as a frame I-beam **71**. Bracket **70** includes a horizontal platform element **72** of inverted chanel-shaped cross section, to which the body **69** of the valve **68** is secured in depending relation. Platform **73** accommodates the piping or tubing which connects valve **68** with a source of pressure supply on the one hand and with the pipe or conduit **54** on the other hand.

A control plunger **74** extends downwardly of valve body **69** and is actuated by a cam follower roller **75** which is appropriately mounted for sliding movement in reference to the valve body **69**. Roller **75** engages the periphery of a generally circular cam **76** secured on a shaft **77**, which may be driven by a bevel gear connection to the main shaft **12** of the apparatus. Cam **76** is shaped to provide diametrically opposed "lows" **78** which, when engaged by follower **75**, cause valve **68** to be opened, thus communicating conduit **54** with the source

of air pressure, as through piping 79 to the valve. At other times, valve 68 is closed.

Opening of master valve 68 takes place as the forming dies 49 mounted in each of die holders 48 emerge from the pulp slurry, from which a layer of fibers has just been suction deposited. Jetting of the forming dies then takes place, for a time determined by the arcuate extent of cam "low" 78, and by the duration of sliding communication of distributor valve 50 with a port 30 of distributor disk 14. At this time communication is completed through the line of swiveled piping to an individual distributor header 45, thence through a platen 47 to the interior of the die holders 48 associated with it.

Figs. 4 through 10 supplement Figs. 1 and 2 in reference to the construction and function of the individual forming dies 49, the mode of mounting the same in a longitudinally extending group on a platen 47 of considerable area, and the relationship to the die and die holder of the individual jet units or assemblies, generally designated 80, by which an air stream is applied to sharply define the margin of an aperture otherwise formed in that surface by the jet unit. Prior to considering these matters it is well to give consideration to the nature of the actual molded pulp carton C (Fig. 3) which the present apparatus is adapted to form. This, as indicated above, is the subject matter of a copending Reifers application but it is also similar, in general reference to its aperturing, to Cox and Koppelman cartons identified above.

Carton C consists of a hollow, open or tray-like cover section *a* having a flat top-forming panel *b* integrally bounded by tapered end and side walls *c*, *d*, respectively. Cover section *c* is integrally hinged by a longitudinally extending crease *e* to a cellular bottom section *f* of the carton, these sections being in generally coplanar relation as removed from the apparatus after drying.

Cellular bottom section *f* is subdivided by integral upstanding transverse and longitudinal partition elements *g*, *h*, respectively, into a plurality of cells *i*, and upstanding post elements *j*, with which the partition elements merge, assist in defining the cells. Finally, an internally disposable reinforcing and locking flap *k* of the carton is integrally hinged to bottom section *f* by a longitudinally extending crease *l*, this flap lying coplanar with the exposed margins of the cover and bottom sections.

The walls of cover section *a* and flap *k* are provided with undulatory formations, generally designated *m*, to increase the egg accommodating space within the carton, and an esesntial feature of carton C is that it is provided with locking apertures *n* in its outer or free cover section wall *d*. One margin of each of these apertures practically coincides with the meeting zone of the wall *d* and top forming panel *b*.

The carton is characterized by a snap locking engagement in apertures *n* of externally projecting locking lugs *o* formed adjacent the outer free edge of the cover enclosed locking flap *k*, the lugs being caused to snap outwardly into the apertures *n* when brought into horizontal register therewith. Accordingly, it is the objective of the improvement shown in Figs. 4–8 to form apertures *n* in such a manner that they present clean-cut and sharply defined margins, free from featheredge, deckle effect or roughness, such as will of course substantially detract from the effectiveness and positiveness of the desired snap locking action.

Turning, then, to Fig. 4, it will be noted that forming die 49 mounted in holder 48 is shaped in an outline corresponding to that of the article depicted in Fig. 3. Fig. 4 shows only a single forming die 49 and individual die holder 48 therefor, it being noted that a number of these are assembled and bolted to the outer surface of a platen 47, in succession longitudinally of the axis of the apparatus (Figs. 1, 2 and 10). These dies are of composite, built-up character, in that each thereof is composed of a single, full length, cover forming die section 81, against which top forming panel *b* and walls *c*, *d* of the carton are deposited; a multi-part bottom forming section 82 abutted against section 81 along a longitudinally extending joint 83, against which section the bottom *f* and its cell formations *g*, *h*, *i*, *j* are molded; and a third flap or flange forming section 84 abutted against section 82 along a longitudinal joint 85.

The cover and flap molding die sections 81, 84 are each formed as a single piece, but the intermediate cell forming section 82 is assembled from a number of component shaped die elements. These include a plurality of individual, intermediate cell forming elements 86 of which there are five in the illustrated adaptation, and a pair of end cell forming sections 86' arranged at the opposite ends of a longitudinal succession of the elements. The forming elements 86, 86' of bottom forming section 82 are abutted against one another at transverse joint lines 87, and they are secured in this assembly by longitudinally extending tie rods 88 passing through integral depending flanges on the respective component cell forming sections 86, 86'. Similarly, the three major sections of forming die 49, i.e. cover, bottom and flap forming sections 81, 82 and 84, respectively, are secured in their abutted engagement at joints 83, 85 by means of transversely extending tie rods 91, these tie rods extending through integral depending webs of the three respective major sections. A built-up die of this character presents laterally extending flanges 94 (Fig. 5) at the margins of the component sections and is secured appropriately at those flanges, as by bolts, screws, or the like, to a corresponding adjacent flange 95 of its associated die holder 48, in the fashion shown in Figs. 4 and 5.

Die 49 is provided throughout its molding area with a multiplicity of perforations 96 of, say, one sixteenth inch diameter, arranged on half inch centers, for the purpose of admitting suction to a wire mesh molding screen 97 which is shaped against and held in fixed relation to the contours of the respective die sections 81, 82, 84.

The thus constituted screen die is clamped at its margins 94 by means of margin straps, as illustrated in Figs. 4 and 5. These include a cover outer side margin strap 98, a margin strap 99 adjacent either end of the die, and a flap margin strap 100 paralleling strap 98 at the opposite, flap side of die 49 and holder 48. Straps, 98, 99, 100 are contoured along their inner margins in approximate conformity with the external outline of die 49; they are secured in clamping relation to the die screen 97 and die margins by means of screws or the like.

As mentioned above, and as shown in Figs. 2 and 10, each large platen 47 has a set of the dies and die holders rigidly secured thereto in a longitudinally spaced, axially extending succession. The rear of the platen is shown in Fig. 9. It is of heavy gauge construction, and provision is made to mount pressure distributor header 45 longitudinally across the rear surface thereof in flush relation thereto, as by grooving the platen longitudinally to receive the header snugly. Platen 47 is provided with a number of relatively large sized openings 101 through which vacuum chamber 23 of suction box 22 (Figs. 1 and 2) is communicated with the interior of the die holders 48. These openings of course have function only in the suction molding and article transfer operations of the apparatus; they have no bearing on the particular jetting operation performed by the present improvement.

Referring specifically now to Figs. 4–8, each of the cover forming die sections 81 of the dies 49 assembled with a given platen 47 is provided with a pair of side openings 102 positioned in the same relation to the wall of this section as the cover lock apertures *n* of the carton C bear to the wall *d* of the latter, as depicted in Fig. 4. Adjacent margins of mesh screen 97 may be drawn

outwardly into these openings **102** (Fig. 5) and held in place by jet assembly **80**.

The construction of the individual jet assemblies **80** is of importance in regard to the most efficient operation of the machine as a whole. Each such assembly comprises an outer jet shell **103** having a main tubular body portion **104** of rectangular cross sectional outline, i.e., corresponding to the outline of the desired aperture *n* and the outline of die aperture **102**. As appears in Fig. 8B, the forward extremity of shell body **104** is outwardly flanged at **105** on its top and sides, thereby enabling a secure grip to be exerted on the screen **97** adjoining aperture **102**. Body **104** merges rearwardly into a cylindrical tubular tail portion **106** which is internally threaded at **107** and is snugly received in a circular aperture **108** of the wall of die holder **48**, with body **104** inclined downwardly and outwardly.

A jet core **109** (Fig. 8A) is frictionally received in the rectangular interior of jet shell **104**. This core has a solid forward body portion **110** of rectangular outline corresponding in shape to that of the shell interior, but of substantially less cross sectional area. Body **110** flares forwardly and outwardly at its top and sides in jet-directing lips **111**, it being noted by reference to Fig. 8B that the forward upper extremity of shell **104** is curled upwardly (also at its sides) at **112** in substantial parallelism with the respective adjacent flared lips **111**. In obtaining a configuration of the core body **110** as described, the same is milled at its top and sides to provide similar under-cut recesses **113** which open forwardly to jet orifices of limited size, variable at will in accordance with the relative axial positioning of jet core **109** in shell **103**. The bottom surface of jet core body **110** is left flat, the body being cut away only slightly at **113'** to afford a further small, forwardly opening jet orifice between the core and shell in this particular bottom area.

Core **109** is completed by four rearwardly extending prong-like legs **114** to hold the same frictionally in the shell, which legs are spaced from one another at the respective four corners of the body **110**. In recessing of core body **110** at **113**, **113'** the core is placed in communication at its top, bottom and sides with the space between the legs **114**, hence in free communication with the pressure supply end of jet assembly **80**. Legs **114** serve a significant purpose in directing the air jet components in the proper directions and in the proper relative volumes of flow to create a proper, though limited, fiber displacing jet action at the top, sides and bottom of the carton aperture.

A hollow tubular clamp screw **115** is threaded into the rear **107** of jet shell **103**, engaging die holder bore **108** to rigidly lock the jet assembly in place, with a sealing gasket **116** interposed. An internal bore **117** of this clamp screw opens to the manifold passage **118** of a specially shaped, transversely extending manifold **119**, such a manifold being secured to the side wall of each die holder **48** in covering relation to the intake bores of the pair of jet assemblies **80** thereon. As indicated in Figs. 1 and 2, each manifold **119** is upwardly connected through a bore **120** at each end thereof and through a grommet-sealed aperture **121** in platen **47** with the main pressure distribution header **45**, as illustrated in Figs. 1, 2, 4, 9 and 10. Hence air supplied through the swiveled piping arrangement of Figs. 1 and 2 is distributed through header **45** and individual manifolds **119** of the respective die holders **48** into the jet assemblies **80** thereof. This is done instantaneously and without substantial frictional resistance to flow.

An air stream entering the jet assembly from its rear is directed forwardly and outwardly between the core legs or prongs **114** and into the relieved marginal zones **113**, **113'** of its body portion, being then caused to travel in extremely restricted, outwardly divergent paths on three sides of the body portion and in a restricted straight forward path on the fourth or bottom side. A minute high velocity current flow thus occurs through individually elongated orifices arranged at right angles to one another, and at just the proper position to sweep the margins of the aperture formed at assembly **80** as screen **97** emerges from the pulp slurry. Fibers in these zones are displaced sharply away from the edges of the assembly with sufficient positiveness to outline a clean-cut pulp edge on all four sides of the assembly, yet in insufficient volume and attendant impact to dislodge fibers immediately adjoining the edges. The undercutting and flaring of the core's top and sides at **113** is true and smooth as to radii and is such as to produce a 90° deflection of the jets at these three surfaces, while the lesser bottom undercut at **113'** produces a straight through flow. The aperture *n* is thus ideally shaped for its intended locking engagement with lug *o*.

Incidentally, reference has been made above to a jetting operation involving the use of air as the jetting medium; however the claims employ the term "fluid" in this connection, and it should be clearly understood that the use of a liquid medium such as water in place of air is quite feasible and has been successfully practiced. Accordingly, the claims should be construed in this light.

The reference numeral **125** in Fig. 2 conventionally designates the usual tank of the molding apparatus, containing a watery slurry of paper pulp fibers **126** the level of which is maintained approximately as indicated at **127**.

In the operation of the apparatus, the molding heads **11** are successively and continuously carried through the slurry **126**, during which time suction in vacuum chamber **23**, created by means with which the present invention does not deal, is communicated through platen openings **101** on the outer side of that chamber with the interior of a set of the box-like die holders **48**. Pulp fibers are drawn onto the surface of molding screens **97**, but the area represented by the forward end of jet assembly **80** has no such deposition thereon, although there is a tendency to build up the fibers around the margin of this area in a deckle or featheredge effect. However, as the screen emerges from the slurry air pressure is established by timing control valve **50**. As the successive individual pressure lines are exposed to the arcuate distributor groove **51** of this valve in the rotation of distributor disk **14**, the pressure is transmitted through the individual piping, including rotatable joint **40**, to elongated distributor header **45**, whence individual manifolds **119** transmit pressure to the jet assemblies **80** connected with each die **49**. Built up wet fibers are dislodged by fluid shearing type of action from the zone of the aperture margin without appreciable disruptive effect.

Jetting action persists for a period of time determined by the angular extent of the "low" **78** on master valve control cam **76**, or by the angular extent of the internal groove of distributor valve **50**, or both, whereupon pressure is shut off. The apparatus then transports the molding head **11** upwardly in an arcuate path to a conveyor for drying forms (not shown), during which travel the individual molding heads partake of swiveling action about their respective rotating supports, in a manner and for a purpose not germane to the present invention. Upon arrival at the drying forms they are transferred thereto; and a similar molding, jetting and transfer cycle ensues upon re-arrival of the molding head at tank **125**.

I claim:

1. Apparatus for forming apertured articles of molded pulp, comprising a forming die surface against which wet fibers are deposited in forming an article, said surface having an opening of the general outline of an aperture desired in the article, a jet unit having an imperforate core presenting a surface exposed in said opening against which fibers do not deposit, an orifice surrounding said last named surface with small side clearance to afford a restricted jet orifice between the same and a margin of said first named opening, and means to

establish a fluid pressure line in communication with said jet orifice.

2. Apparatus for forming apertured articles of molded pulp, comprising a forming die surface against which wet fibers are deposited in forming an article, said surface having an opening of the general outline of an aperture desired in the article, and a jet unit disposed in said opening, said unit comprising an internal core having an imperforate forward surface positioned within said opening against which fibers do not deposit, and a tubular shell surrounding said core surface with small side clearance to afford a forward jet orifice between the core and shell.

3. Apparatus for forming apertured articles of molded pulp, comprising a forming die surface against which wet fibers are deposited in forming an article, said surface having an opening of the general outline of an aperture desired in the article, and a jet unit disposed in said opening, said unit comprising an internal core having an imperforate forward surface positioned within said opening against which fibers do not deposit, and a tubular shell surrounding said core surface with small side clearance to afford a forward jet orifice between the core and shell, adjacent surfaces of said core and shell being flared forwardly and outwardly at said jet orifice.

4. Apparatus for forming apertured articles of molded pulp, comprising a forming die surface against which wet fibers are deposited in forming an article, said surface having an opening of the general outline of an aperture desired in the article, and a jet unit disposed in said opening, said unit comprising an internal core having an imperforate forward surface positioned within said opening against which fibers do not deposit, and a tubular shell surrounding said core surface with small side clearance to afford a forward jet orifice between the core and shell, said core having a plurality of elements extending rearwardly away from said imperforate surface in releasable frictional engagement with the interior of said shell.

5. Apparatus for forming apertured articles of molded pulp, comprising a forming die surface against which wet fibers are deposited in forming an article, said surface having an opening of the general outline of an aperture desired in the article, and a jet unit disposed in said opening, said unit comprising an internal core having an imperforate forward surface positioned within said opening against which fibers do not deposit, a tubular shell surrounding said core surface with small side clearance to afford a forward jet orifice between the core and shell, and means to establish a fluid pressure line through said jet unit to said jet orifice, said core having a plurality of elements extending rearwardly away from said imperforate surface in releasable frictional engagement with the interior of said shell, said core being laterally recessed forwardly of said elements so as to connect said orifice between said elements with said last named fluid pressure means.

6. Apparatus for forming apertured articles of molded pulp, comprising a forming die surface against which wet fibers are deposited in forming an article, said surface having an opening of the general outline of an aperture desired in the article, and a jet unit disposed in said opening, said unit comprising an internal core having an imperforate forward surface positioned within said opening against which fibers do not deposit, and a tubular shell surrounding said core surface with small side clearance to afford a forward jet orifice between the core and shell, said core having a plurality of of elements extending rearwardly away from said imperforate surface in releasable frictional engagement with the interior of said shell, adjacent surfaces of said core and shell being flared forwardly and outwardly at said jet orifice.

7. Apparatus for forming apertured articles of molded pulp, comprising a forming die surface against which wet fibers are deposited in forming an article, said surface having an opening of the general outline of an aperture desired in the article, and a jet unit disposed in said opening, said unit comprising an internal core having an imperforate forward surface positioned within said opening against which fibers do not deposit, a tubular shell surrounding said core surface with small side clearance to afford a forward jet orifice between the core and shell, and to establish a fluid pressure line through said jet unit to said jet orifice, said core having a plurality of elements extending rearwardly away from said imperforate surface in releasable frictional engagement with the interior of said shell, said core being laterally recessed forwardly of said elements so as to connect said orifice between said elements with said last named fluid pressure means, adjacent surfaces of said core and shell being flared forwardly and outwardly at said jet orifice.

8. Apparatus for forming apertured articles of molded pulp, comprising a foraminate molding form, means for molding a wet article on said form, including a movable support on which said form is mounted to transport the same through a slurry of fibers and means to deposit under suction a layer of said fibers on a surface of said form as it traverses said slurry, said surface having an imperforate area which is bounded at least in part by a restricted jet orifice, and a pressure supply line to discharge fluid through said jet orifice and thereby create at said orifice a jet for defining a margin of an aperture in said article resulting from the non-deposition of fibers at said imperforate area.

9. Apparatus for forming apertured articles of molded pulp, comprising a foraminate molding form, means for molding a wet article on said form, including a movable support on which said form is mounted to transport the same through a slurry of fibers and means to deposit under suction a layer of said fibers on a surface of said form as it traverses said slurry, said surface having an imperforate area which is bounded at least in part by a restricted jet orifice, a pressure supply line to discharge fluid through said jet orifice and thereby create at said orifice a jet for defining a margin of an aperture in said article resulting from the non-deposition of fibers at said imperforate area, and means operating in timed relation to movement of said form support to forward fluid through said line upon emergence of said form surface from said slurry.

10. Apparatus for forming apertured articles of molded pulp, comprising a foraminate molding form, means for molding a wet article on said form, including a movable support on which said form is mounted to transport the same through a slurry of fibers, means pivoting said form on said support, and means to deposit under suction a layer of said fibers on a surface of said form as it traverses said slurry, said surface having an imperforate area which is bounded at least in part by a restricted jet orifice, and a pressure supply line to discharge fluid through said jet orifice and thereby create at said orifice a jet for defining a margin of an aperture in said article resulting from the non-deposition of fibers at said imperforate area, said supply line including fixed piping and a joint rotatable about its axis for placing the same in pressure communication with said orifice.

11. Apparatus for forming apertured articles of molded pulp, comprising a foraminate molding form, means for molding a wet article on said form, including a movable support on which said form is mounted to transport the same through a slurry of fibers, means pivoting said form on said support, and means to deposit under suction a layer of said fibers on a surface of said form as it traverses said slurry, said surface having an imperforate area which is bounded at least in part by a restricted jet orifice, a pressure supply line to discharge fluid through said jet orifice and thereby create at said orifice a jet for defining a margin of an aperture in said article resulting from the non-deposition of fibers at said imperforate area, said

supply line including fixed piping and a joint revolving about its own axis for placing the same in pressure communication with said orifice, and means operating in timed relation to movement of said form support to forward fluid through said line upon emergence of said form surface from said slurry.

12. A foraminous mold for forming molded pulp cartons having cover sections which interlock by the engagement of apertures and projecting lugs formed therein, comprising a plurality of associated die sections contoured to form such a carton including its cover sections, a wire mesh screen covering each of the die sections for the deposition of pulp fibers thereon to form a carton, one of said die sections having projections designed to form the projecting lugs and another one of the die sections having openings corresponding to the apertures desired in a carton molded thereon, a jet unit mounted in each of said openings, each jet unit having an imperforate core projecting through the screen and presenting a surface against which fibers do not deposit, and an orifice closely surrounding each core and communicating with a source of fluid pressure.

13. Apparatus for forming apertured articles of molded pulp, comprising a forming die surface against which wet fibers are deposited in forming an article, said surface having an opening of the general outline of an aperture desired in the article, and a jet unit disposed in said opening, said unit comprising an internal core having an imperforate forward surface positioned within said opening and a tubular shell surrounding said core surface with small side clearance to afford a forward jet orifice between the core and shell.

14. The method of forming a molded pulp article having an aperture therethrough comprising immersing a suction mold in a slurry of pulp fibers and applying suction thereto to draw liquid inwardly of the mold and form a layer of interlaced pulp fibers on the surface of the mold, then withdrawing the mold from the slurry, and then directing a hollow stream of gas under pressure from the interior of the mold outwardly of the mold through the layer of pulp on the mold so that thin marginal portions of said stream are directed along the outline of the desired aperture while maintaining suction within the mold to hold the layer of fibers in position on the mold and while the fibers are wet and relatively free to slip apart from each other.

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