April 4, 1939. G. A. MOORE 2,152,813

MEANS FOR APPLYING AND REGULATING PRESSURES

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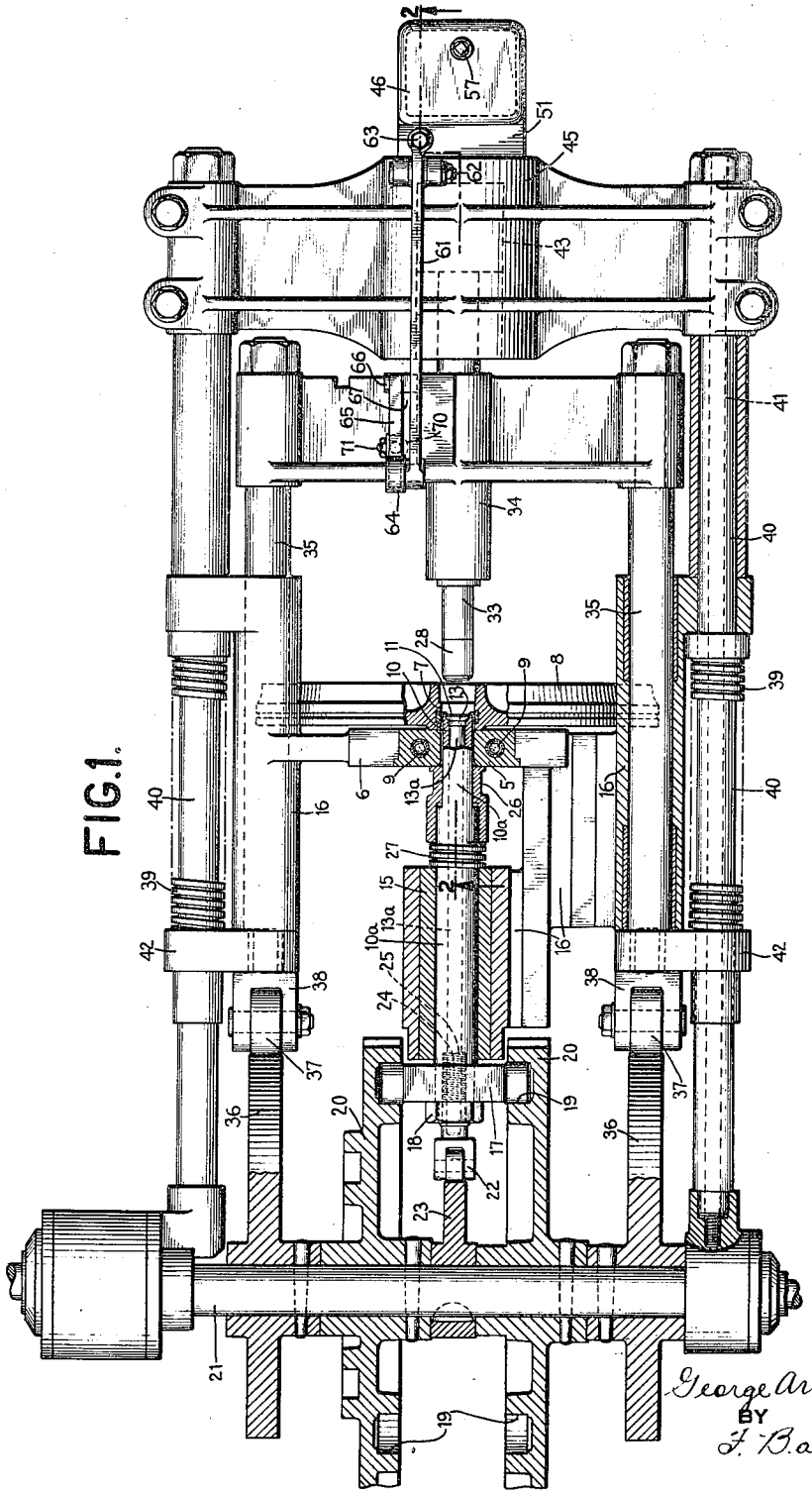


FIG.1.

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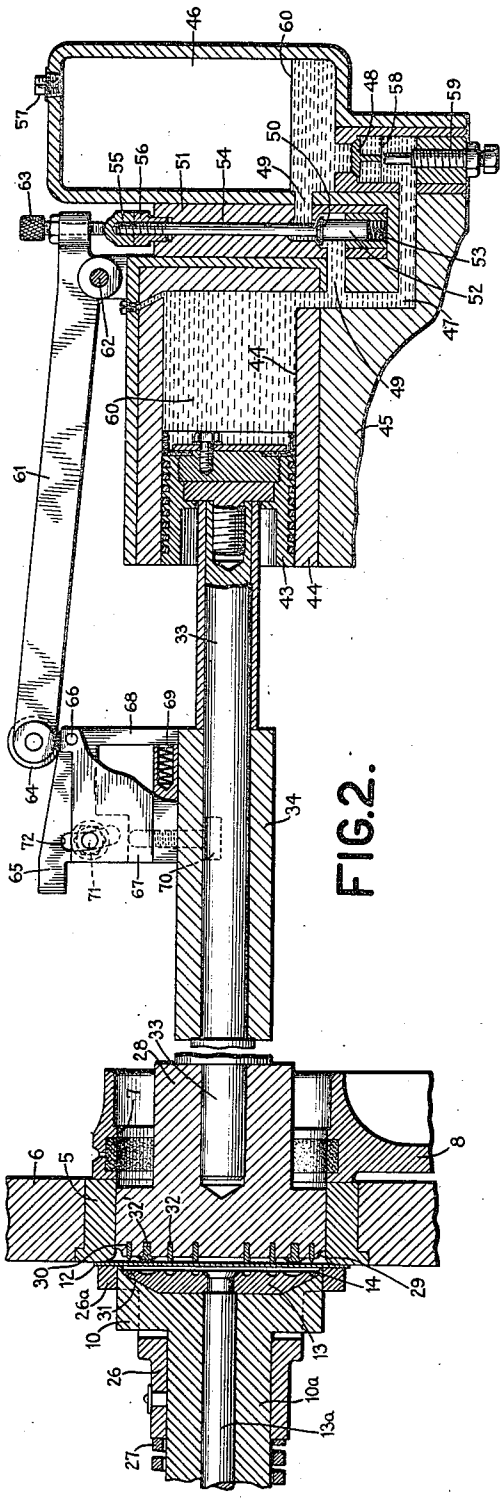


FIG. 2.

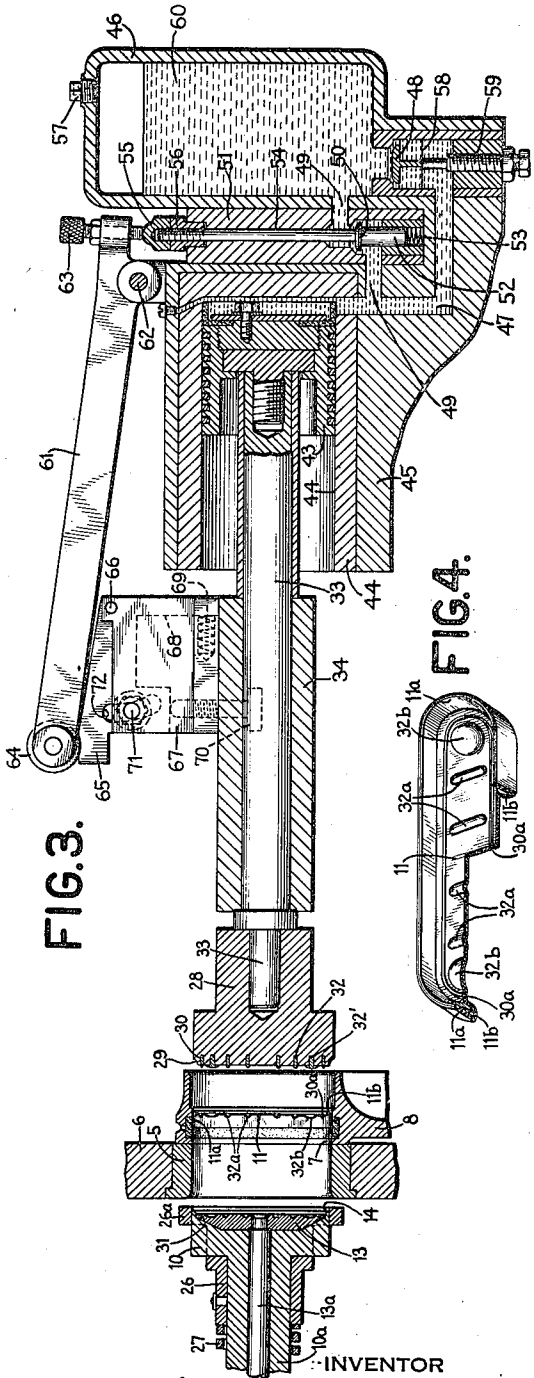


FIG. 3.

FIG. 4.

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MEANS FOR APPLYING AND REGULATING PRESSURES

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5 Claims. (Cl. 113—46)

This invention relates to pressure applying and pressure regulating means, and more particularly to means adapted to control the effective pressure applied to fibrous articles, for example, for embossing or deforming the same by controlling the reaction to the pressure applying means.

One of the objects of the present invention is to provide novel pressure regulating apparatus of the type embodying means for yieldingly and variably resisting a force.

Another object is to provide novel means for varying the pressure exerted by one of a pair of movable members upon the other.

Still another object is to provide novel apparatus which is so constructed that the resistance to movement of parts thereof may be varied in a predetermined manner in accordance with the displacement of said parts from any reference position.

A further object is to provide novel die apparatus comprising means for varying the pressure exerted by one die against another and controlling the pressure variations by the movement of one of the dies.

A still further object is to provide novel apparatus adapted for use in embossing, scoring and/or drawing materials such, for example, as articles or blanks comprising fibrous and/or metallic materials.

Another object is to provide novel means whereby the movement of a member may be variably resisted, said means being adjustable to alter the curve of resistance values plotted in terms of positions of the member.

The above and further objects and novel features of the invention will more fully appear from the following detailed description taken in connection with the accompanying drawings. It is to be expressly understood, however, that the drawings are for the purpose of illustration only and are not designed as a definition of the limits of the invention, reference being primarily had for this latter purpose to the appended claims.

In the drawings, wherein like reference characters refer to like parts throughout the several views,

Fig. 1 is a top plan, partly in section and with parts broken away, illustrating one form of apparatus embodying the present invention;

Fig. 2 is a side elevation, partly in section and with parts broken away, of a portion of the mechanism shown in Fig. 1, the section being taken substantially on line 2—2 of Fig. 1 but with the movable parts in a different position;

Fig. 3 is a view similar to Fig. 2 illustrating the parts in still another position; and,

Fig. 4 is an enlarged view of one form of an embossed and scored flanged article which may be made with the apparatus of Fig. 1.

In the single embodiment of the invention illustrated by way of example, the novel pressure regulating means comprehended are shown in combination with cooperating male and female die members adapted for use in drawing flanged articles from blanks, comprising fibrous materials, and in producing grooves, scores or other deformations in said blanks or articles. The drawing and embossing dies as shown comprise a female die 5 (Fig. 2) stationarily mounted in a suitable support 6 and a revolvable transfer die 7 constituted by an opening adjacent the periphery of a turret 8, the latter being adapted to be rotated so as to bring said opening into register with female die 5. If desired, suitable heating means, such as electric heating coils 9, may be provided in die 5 (Fig. 1) to heat the same and facilitate the forming and drawing operations to be hereinafter described.

The male die assembly through which pressure is applied comprises, in the form illustrated, a die member 10 adapted to be moved into female die 5 and transfer die 7 and having a peripheral outline corresponding in shape to the inner periphery of said female and transfer dies, which, in the embodiment shown, are oblong with straight parallel sides and arcuate portions connecting said sides. The peripheral dimensions of die 10 are somewhat smaller than those of female die 5 to provide an annular space of suitable proportions to accommodate the flange 11*a* of an article 11 (Fig. 4) adapted to be formed by drawing the marginal portion of a blank 12 into right angular relation with the central portion thereof in a manner to hereinafter appear. A stripper die 13 fits into a recess in die 10 in such a manner that a peripheral rib 14 in the latter die projects beyond the face of said stripper when the latter is in housed position in said recess, as best seen in Fig. 2. Male dies 10 and 13 are mounted on concentric rods 10*a* and 13*a* respectively, said rods, and hence dies 10 and 13, being adapted to be reciprocated either in unison or relatively to each other by any suitable means such as rotatable cams.

Rod 10*a*, as shown, is slidably supported in a bearing 15 (Fig. 1) in the frame structure 16 and is adapted to be reciprocated by means of a

cross-head 17 which is secured thereon by a nut 18 and engages identical cam grooves 19 in the web portions of a pair of gears 20. The latter are pinned to a rotatable shaft 21 and adapted to be rotated by any suitable means, such as pinions (not shown), which preferably engage the toothed peripheries of said gears. Rod 13a slidably extends through rod 10a and has a bifurcated member 22 secured to the end thereof, said member having a roller mounted thereon for engagement by a cam 23 which is keyed to shaft 21 for rotation therewith. A spring 24 is interposed between the inner end of member 22 and a shoulder 25 in an enlarged bore of rod 10a to hold stripper 13 in engagement with die 10 and yieldingly hold the same against relative movement by cam 23.

Slidably mounted on rod 10a adjacent die 10 is a pressure member 26 which is provided with a flange portion 26a that extends around and slidably engages the periphery of die 10. Flange 26a is yieldingly held in contact with the margin of blank 12 by a coil spring 27 which is interposed between bearing 15 and member 26. The latter member may be retracted from female die 5 by die 10 when the latter is withdrawn from the female die by cams 19 to permit the insertion of a blank 12 between the male die assembly and said female die (Fig. 3). Preferably, member 26 is engaged by die 10 only after said die has been completely withdrawn from the female die, thereby permitting flange 26a to engage blank 12 prior to engagement thereof by rib 14 upon the movement of the parts to the right, as viewed in the drawings. Because of the reduced size of Fig. 1, member 26, 26a is illustrated somewhat diagrammatically therein.

A footing or buffer die 28, adapted to be reciprocated through transfer die 7 and into female die 5 in sliding engagement with the walls thereof, is provided to resist movement of die 10, 13 and thus create a pressure on blank 12 and to cooperate therewith for drawing flange 11a and impressing the desired deformations in blank 12. To this end the face of die 28 has a peripheral recess 29 for receiving rib 14 of die 13 to form a groove and complementary rib 11b in blank 12, a wedge shaped cutting edge or knife 30 projecting from the face thereof opposite similarly shaped grooves 31 in die member 13 (Fig. 2), and a plurality of ribs 32 and buttons 32' opposing similar indentations on die 13. It will be understood that additional deformations or scores may be made in blank 12, if desired, by providing the necessary ribs or cutting edges and cooperating grooves in die members 10, 13 and 28.

Die 28 as shown is mounted on a rod 33 carried by a cross-head 34. The latter is secured to and movable with a pair of sliding rods 35 (Fig. 1) which are slidably supported by suitable bearings in frame 16. As will be more fully pointed out hereinafter, buffer die 28 is moved during the first portion of its movement to the right from the position of Fig. 2 by die 10, 13 and during the remainder of such movement by a pair of cams 36 mounted on shaft 21 for rotation therewith and adapted to engage rollers 37 mounted on bifurcated members 38 secured to the ends of rods 35. Rollers 37 are held in engagement with cams 36 except as hereinafter pointed out, and die 28 is biased toward the left by a pair of coil springs 39 interposed between collars on sleeves 40 which are stationarily mounted on tie rods 41 and a pair of blocks 42 mounted on sliding rods 35 and slidably engaging sleeves 40 (Fig. 1).

From the drawings, it will be seen that as dies 10 and 13 are moved in unison to the right by cams 19 from the position shown in Fig. 2, blank 12 is first engaged by flange 26a of pressure member 26 and thereafter by rib 14 on die 10, the latter being effective to draw material from the margin of said blank into recess 29 and thus emboss a peripheral groove 11b in article 11 without rupturing or unduly straining the material of the blank. During the formation of said groove, the central portion of the blank is engaged by the face of stripper 13 and pressed against knife edge 30 whereby said blank is scored to provide a line of weakness so that an opening may be made therein by digital pressure. At the termination of the scoring and embossing operation, blank 12 will be engaged by and firmly held between the faces of dies 10, 13 and die 28, the intensity of the pressure being determined by the reaction of the latter die while said dies move to the right through female die 5 to draw the remainder of the marginal portion of blank 12 from beneath member 26, 26a and into flanged relation with the central portion thereof.

In order to obtain the most satisfactory results in the formation of article 11, it is highly desirable that the embossing and/or scoring operation be completed and the blank firmly clamped between dies 13 and 28 before any substantial movement of the latter die from normal position (Fig. 2) or in other words before the drawing of flange 11a except that portion which forms the outer wall of groove 11b is begun. Although there should be some slight yielding movement of buffer 28 as die 10, 13 contacts blank 12, the reaction of the buffer should build up very rapidly. The initial yielding prevents a too sudden shock to the blank which is of comparatively fragile material, permitting the fibers to start flowing in the desired direction and to enable knife 30 to make a clean cut furrow 30a in the blank without rupturing the same or destroying its impermeability. Ribs 32a and buttons 32b are embossed on the blank at substantially the same time by raised portions 32 and 32' respectively.

After the embossing and scoring are completed, the reaction by buffer die 28 should be sufficiently decreased to permit movement of the same in response to the force applied thereto by die 10, 13 but at the same time maintained sufficiently high to firmly clamp the central portion of the blank 12 between the dies and thus prevent any stretching or straining thereof during the drawing of flange 11a which might destroy the impermeability of article 11 particularly along the line of score 30a. The pressure required in clamping blank 12 between dies 13 and 28 may be gradually diminished during the drawing of flange 11a since the tendency to stretch or strain the fibers of the central portion of the blank decreases as the drawing of said flange progresses. After the completion of the flange drawing operation, the resistance of die 28 may be reduced to a very low value, thus obviating any unnecessary strain on the parts and consequent waste of energy and, in the present embodiment, minimizing the force required to be exerted by cams 36 to impart continued movement to die 28 beyond the limit of movement of die 10, 13 to the right for a purpose to hereinafter appear.

Novel pressure regulating means are comprehended by the present invention whereby the reaction of die 28 to the forces applied thereto and hence the pressure exerted on blank 12 by die 10, 13 may be controlled in a predetermined manner

such as in accordance with the foregoing requirements. Such means, in the form illustrated, comprise hydraulic mechanism including automatic means operated by movement of die 28 to control the reaction of the latter to a force exerted thereon. The hydraulic mechanism, as shown, consists of a piston assembly 43 (Figs. 2 and 3) mounted on the end of rod 33 opposite buffer die 28 and having a fluid-tight sliding engagement with a cylinder liner 44, the latter being fitted into a casting 45 which is supported by tie rods 41 (Fig. 1). Cylinder 44 has communication with a fluid reservoir or chamber 46 in said casting through a passage 47 controlled by a valve 48 and through a second passage 49 controlled by a valve 50.

In the illustrated embodiment, valve 50 is housed in a plug 51 inserted in casting 45 between chamber 46 and cylinder 44, said plug having an opening extending laterally therethrough which constitutes a part of passage 49. The effective size of said passage is determined by the position of valve 50, which is provided with a depending guide rod 52 that engages a spring 53, the latter tending to hold said valve in position to close passage 49. Valve 50 is also provided with a stem 54 which extends upwardly through plug 51 and has an adjustable cap 55 and a lock nut 56 threaded onto the upper end thereof whereby the length of the stem may be varied for a purpose to appear hereinafter.

Valve 48 is preferably a floating valve adapted to be actuated by the differential of pressures in cylinder 44 and chamber 46, the same being adapted to be moved to closed position when the greater pressure exists in said cylinder. The interior of chamber 46 is under atmospheric pressure at all times, the same being vented to atmosphere through a refilling plug 57 threaded into the upper wall thereof. Valve 48 is held in alignment with its seat by a plurality of radially extending guide fins 58 which slidably engage the walls of passage 47. The opening movement of said valve is limited by an adjustable screw or stop 59 thereby permitting adjustment of the maximum flow area from chamber 46 to cylinder 44 through passage 47 and hence control of the return or left-hand movement of piston 43 and buffer die 28 as well as the initial reaction of the latter to right-hand movement, as will more fully appear hereafter.

The resistance of piston 43 and hence die 28 to movement to the right is controlled by regulating the resistance to the flow of an incompressible fluid 60, such, for example, as castor oil, from cylinder 44 into reservoir 46. Said flow resistance may be controlled by varying the area of the connecting passages 47 and 49 in relation to the speed of movement of said die and piston, the speed of die 28 during its movement to the right being determined in the illustrated embodiment by the contour and speed of rotation of cams 19 and 36.

For the purpose of varying the flow area through passage 49 and hence the pressure exerted upon blank 12 between the faces of die 10, 13 and buffer die 28, novel means are provided for controlling valve 50 in accordance with the movement of said buffer die and in the form shown such means comprise a first-class lever 61 pivotally mounted at 62 on casting 45. An adjustable screw 63 is threaded through one end of said lever and engages the upper end of valve stem 54, 55. The other end of lever 61 has a roller 64 mounted thereon which engages the surface of an adjustable cam 65 which is mounted on cross-head 34 for movement with buffer die 28. Cam member 65, as shown, is made in the form of a bell-crank pivoted at 66 on a bracket 67 secured to cross-head 34, the depending arm 68 thereof being engaged by spring 69 which tends to pivot the cam in a counterclockwise direction. The cam surface of member 65, in the form illustrated, slopes upwardly to the left so that as die 28 and hence cam 65 are moved to the right the latter is effective to pivot lever 61 in a clockwise direction whereby valve 50 is gradually moved to open position to progressively increase the flow area through passage 49 and thus progressively decrease the resistance to the movement of piston 43 and buffer 28. During the movement of piston 43 to the right, it will be noted that valve 48 is held in closed position (Fig. 2) by the liquid pressure in cylinder 44.

In order to vary the opening of valve 50 for any given position of die 28 or to vary the rate at which said valve is opened for a given speed of movement of said die, means are provided for adjusting cam member 65. Such means as shown comprise a set screw 70 which is threaded through the base of bracket 67 and engages a lock on the lower face of the horizontal arm of said cam member. A very fine adjustment of the cam may thus be made, the same being held in adjusted position by a clamp bolt 71 which extends through bracket 67 and an arcuate slot 72 in the cam member. The position of valve 50 for any given position of piston 43 and die 28 may also be varied by adjusting cap 55 to alter the length of stem 54 or by adjusting set screw 63 on lever 61. Preferably, the above described flow control means are so adjusted that valve 50 is slightly open when the parts are in the position shown in Fig. 2.

As pointed out above, die 28 and the parts movable therewith are returned from the position of Fig. 3 to the normal position of Fig. 2 by coil springs 39 which are compressed by blocks 42 (Fig. 1) during the right-hand movement of said die. The return or left-hand movement of die 28 is, however, controlled by cams 36, the contours of which are such as to stop said die in the position of Fig. 2 wherein the knife edges 30 are substantially flush with the surface of female die 5. The relation of cams 19 to cams 36 is such that die 10, 13 is never permitted to engage buffer die 28 but, on the other hand, such that when a blank 12 is inserted between said dies, rollers 37 will be held out of engagement with cams 36 by a few thousandths of an inch, due to the thickness of said blank. The pressure exerted on the blank as the dies move to the right is thus determined by the reaction of die 28 to movement by die 10, 13 until flange 11*a* has been drawn, after which rollers 37 are again engaged by cams 36 to move die 28 away from the blank and out of transfer die 7 (Fig. 1).

Die members 10 and 13, which are shown at the limit of their movement to the right in Fig. 1, are adapted to be withdrawn from dies 5 and 7 by cams 19 after buffer die 28 has been moved out of engagement with article 11 by cams 36. In order to insure that flanged article 11 will remain in transfer die 7 (Fig. 3) when dies 10 and 13 are withdrawn, die 10 is first moved to the left by cams 19 while stripper 13 is held against such movement by cam 23. As soon as article 11 has been thus stripped from die 10, the contour of cam 23 falls off so as to permit die 13 to be retracted by spring 24 into the recess in the face of die 10. After die 10, 13 has been moved to the

left beyond the plane of the lower face of flange 26*a*, member 26 is engaged thereby (Fig. 3) and moved to the left against the pressure of spring 27 enough to permit the insertion of a blank 12.

As heretofore pointed out, when die 10, 13 is again moved to the right, it is desirable that there be some initial yielding by buffer 28 but that the reaction thereof should build up to a maximum very rapidly to facilitate the scoring of blank 12 by knife 30. This desirable result may be obtained by proper adjustment of valves 48 and 50, and more particularly of the former, the maximum opening of which is determined by threaded stop 59. When pressure is suddenly applied to die 28 by die 10, 13 and hence to the liquid in cylinder 44, there is an initial escape of some of said liquid from the cylinder into reservoir 46 past valve 48. The quantity of liquid thus escaping constitutes a measure of the initial movement of die 28 and is itself measured by the adjustment of valve 48. The greater the opening of said valve, the greater will be the time required for the same to close, and the greater will be the quantity of escaping liquid. The instant that valve 48 reaches its closed position, however, the pressure in cylinder 44 and hence the reaction of die 28 to movement builds up to a maximum very rapidly, valve 50 being only slightly open at this time. In one embodiment of the invention, it has been found suitable to employ a maximum pressure or resistance by buffer 28 of from 1500 to 3500 pounds per square inch for scoring and deforming blank 12. As pointed out above, this pressure may be built up rapidly, substantially at the instant of impact, if desired. With the contour of cam 65 as shown, the reaction of die 28 tapers off gradually from maximum to a minimum which is determined by the pressure of springs 39. Cam 65 is preferably so contoured and springs 39 are of such size that the mean pressure on blank 12 after the deformation thereof is approximately 85 pounds per square inch.

A complete cycle of operation of the embodiment illustrated is as follows: Starting with the parts as seen in Fig. 2, i. e., with flange 26*a* resiliently held in engagement with the margin of blank 12 by spring 27 and with rib 14 of die 10 about to engage said blank, continued movement of die 10, 13 to the right by rotating cams 19 causes the material of the blank to be drawn into groove 29 by rib 14 to emboss the blank as at 11*b*. During the first part of the embossing operation, buffer die 28 yields slightly, depending on the adjustment of screw 59 and hence the maximum opening of valve 48. The latter closes under the influence of the increasing pressure in cylinder 44, which pressure reaches a peak substantially at the instant valve 48 reaches its closed position, and since valve 50 is also slightly open at this time. The peak pressure and hence the maximum reaction of buffer 28 is preferably reached at the instant the face of stripper 13 engages blank 12 and presses the same against scoring knife 30. The fibers of the blank will under these conditions be cleanly sheared to form a furrow 30*a*, and deformations 32*a* and 32*b* will be impressed in the blank by members 32 and 32' respectively. The central portion of blank 12 will then be firmly gripped between dies 13 and 28, but the pressure exerted thereon by said dies, as the same continue to be moved to the right to draw the margin of blank 12 into female die 5 and thus form flange 11*a*, gradually decreases, due to the opening of valve 50 by lever 61 and cam 65 which moves with die 28. After flange 11*a* has been drawn, and preferably after article 11 has been moved to the position shown in Fig. 1, rollers 37 are engaged by cams 36, whereby die 28 is moved away from the article and clear of turret 3. Thereafter, cams 19 are effective to withdraw die 10 while die 13 is held by cam 23 to serve as means for stripping article 11 from die 10. When die 10, 13 has been completely withdrawn from female dies 5 and 7 by cams 19, turret 3 may be rotated by any suitable means (not shown) to bring another opening 7 into registry with female die 5. Further rotation of cams 36 then permits springs 39 to move buffer 28 back to the position of Fig. 2, during which movement a suction is created in cylinder 44, causing valve 48 to open and permit fluid 60 to flow freely from chamber 46 into said cylinder. A new blank 12 may now be inserted beneath die 10, 13 (Fig. 2) and the cycle repeated.

There is thus provided novel apparatus for embossing, drawing and/or scoring materials which apparatus embodies novel pressure control means for varying the pressure exerted on an article in a predetermined manner. Although only a single embodiment of the invention has been illustrated and described, it is to be expressly understood that the same is not limited thereto but that many changes may be made therein without departing from the spirit and scope of the invention. For example, the surface of cam 65 may have any desired contour for the purpose of varying the reaction of buffer 28 in any desired manner. Various other changes may also be made in the design and arrangement of parts illustrated. Reference will be had primarily to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. In apparatus of the class described, a movable member, cam means for moving said member in one direction at a predetermined rate, automatic means for varying the resistance of said member to movement comprising a fluid chamber, said chamber being at least partially filled with an incompressible fluid, an element operatively connected to said movable member and effective to vary the volume of said fluid chamber, valve means for controlling the egress of fluid from said chamber and means controlled by movement of said movable member for actuating said valve, resilient means for moving said member in the opposite direction, and cam means for controlling the movement of said member by said resilient means.

2. In apparatus of the class described, a die member, cam means for moving the same in one direction, a buffer die adapted to yieldingly resist movement of said member in said direction, means for varying the resistance of said buffer die, said last-named means being operative in accordance with the movement of the buffer die, resilient means for moving said buffer die in the opposite direction, and cam means for controlling the movement of said buffer die by said resilient means.

3. In apparatus of the class described, a die, cam means for moving said die, a buffer die adapted to yieldingly resist movement of said first-named die in one direction, said dies having complementary deformations in the faces thereof for deforming an article placed therebetween, means controlled by movement of said buffer die and including cam means for gradually decreasing the resistance thereof to movement

whereby the pressure exerted on said article is varied, resilient means for moving said buffer die in the opposite direction, and cam means for controlling the movement of said buffer die by said resilient means.

4. In apparatus of the class described, a pair of reciprocable members having complementary deformations in the faces thereof capable of deforming an article placed therebetween, cam means for moving said members in one direction, means for variably resisting movement thereof to cause the same to first exert an increasing pressure and then a decreasing pressure on said article, resilent means for moving one of said members in the opposite direction, and additional cam means for controlling the movement of said last-named member by said resilient means.

5. In apparatus of the class described, a movable member, cam means for reciprocating said member, an element for yieldingly resisting movement of said member in one direction, means for varying the resistance offered by said element, said last-named means being operable in accordance with the movement of said element, resilient means for moving said element in the other direction, and cam means for controlling the movement of said element by said resilient means.

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