May 14, 1963 R. V. PAGENDARM 3,089,393

DRIVE MECHANISM FOR FOLDING BOX MACHINES OF THE PLUNGER AND DIE TYPE

Filed March 13, 1962 4 Sheets-Sheet 1

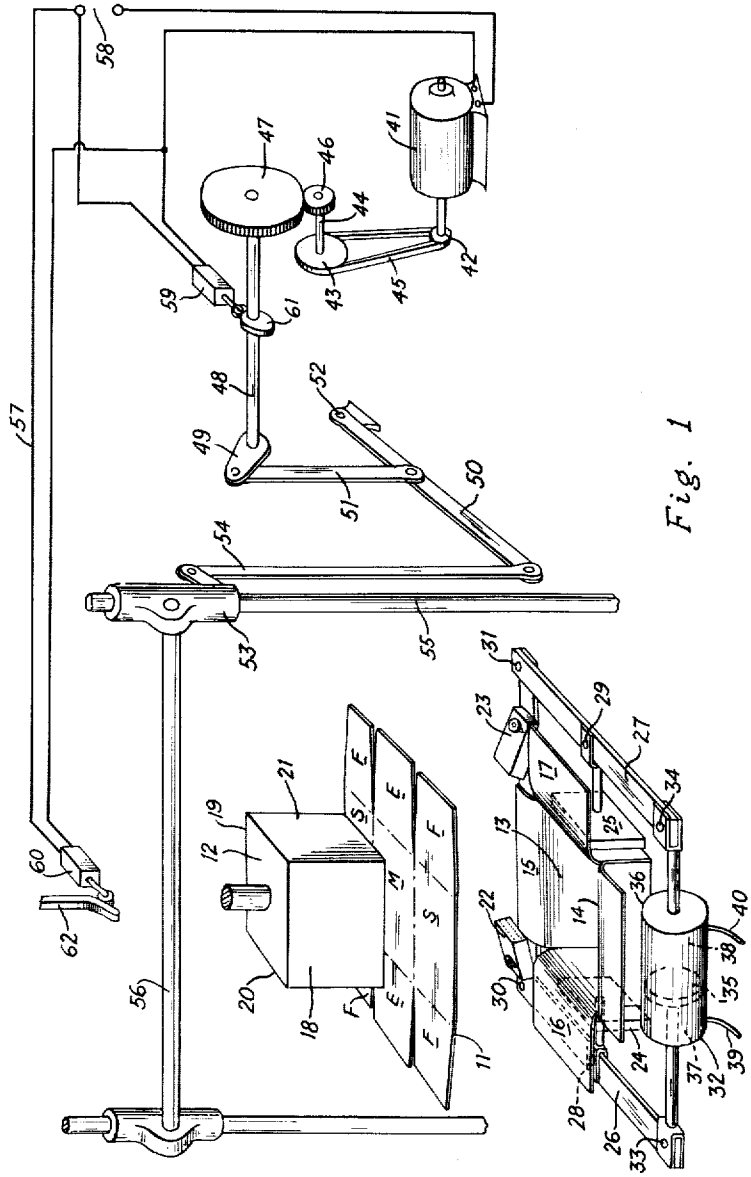


Fig. 1

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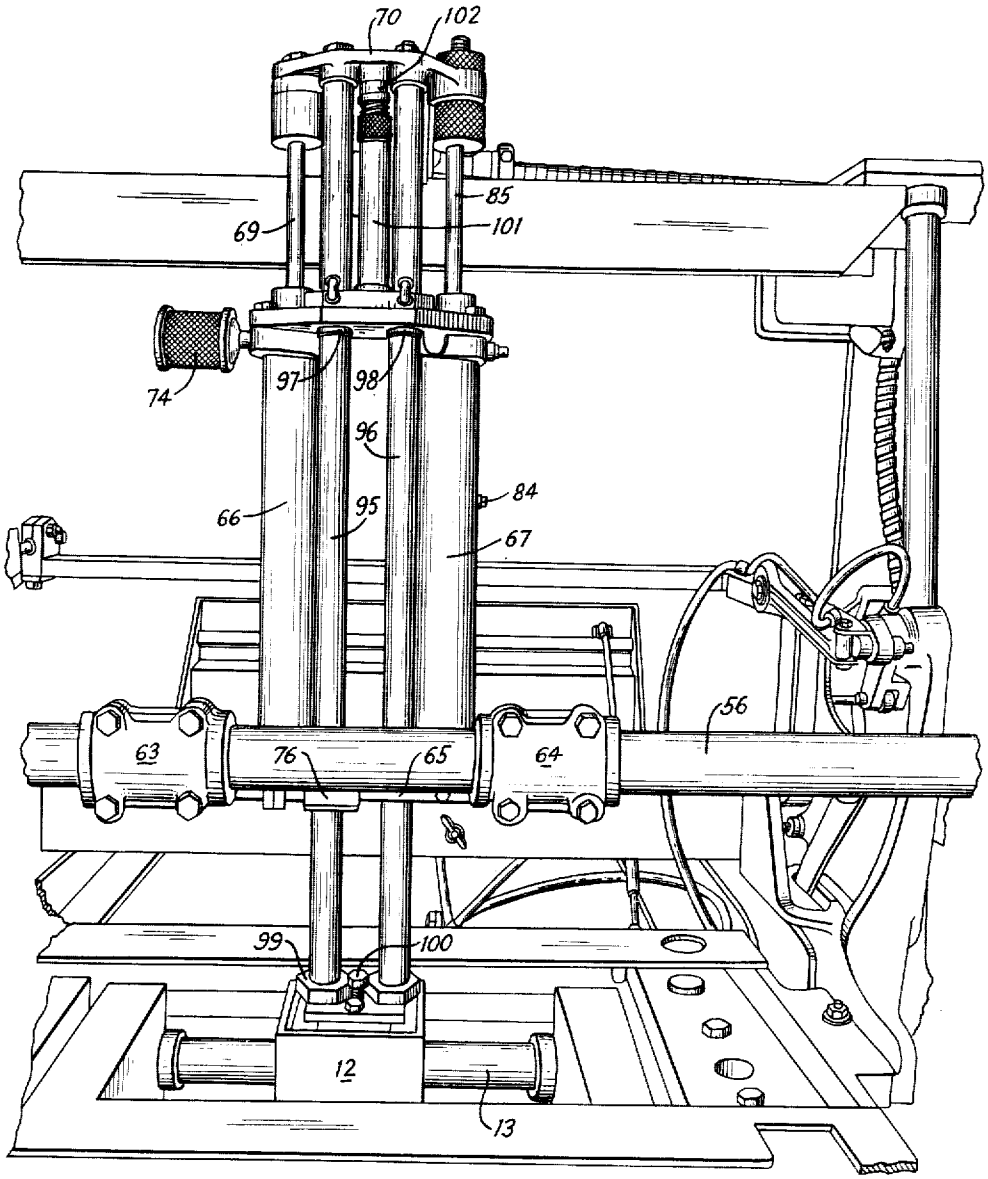


Fig. 2

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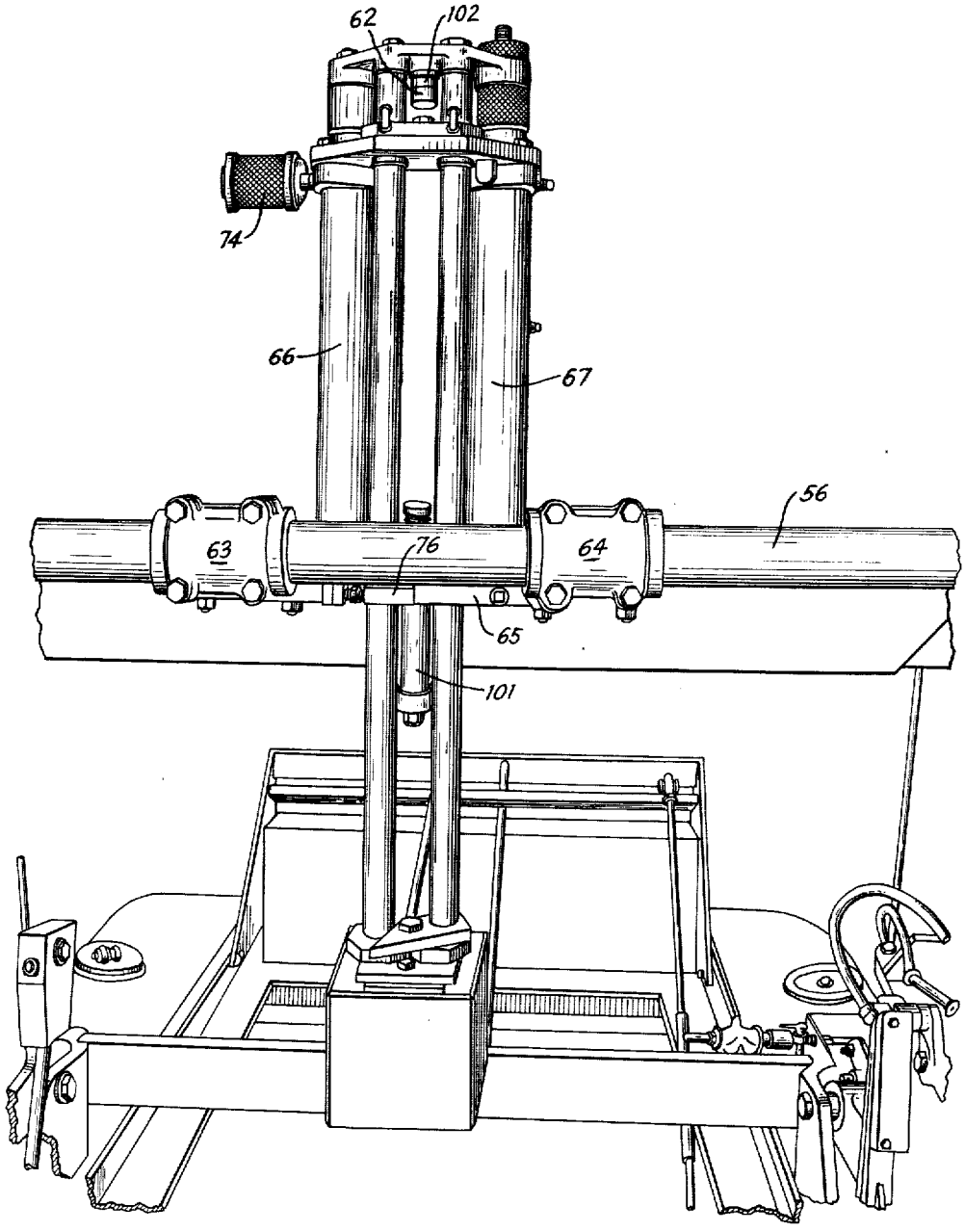


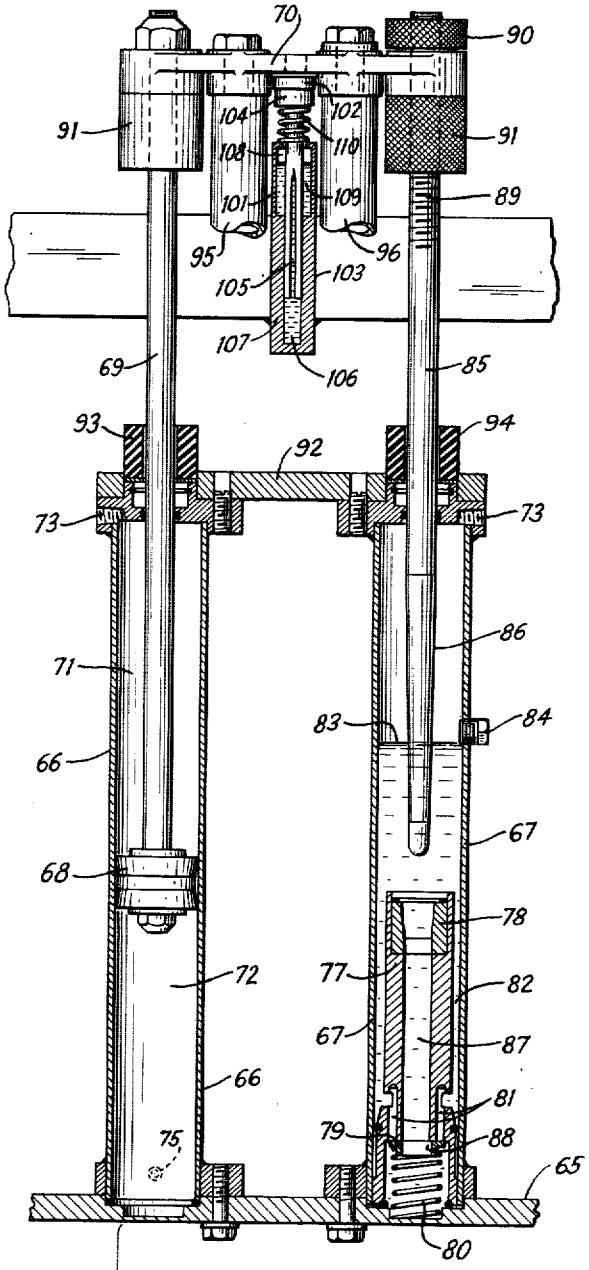
Fig. 3

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DRIVE MECHANISM FOR FOLDING BOX MACHINES OF THE PLUNGER AND DIE TYPE

Filed March 13, 1962 4 Sheets-Sheet 4



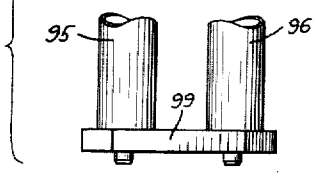


Fig. 4

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United States Patent Office 3,089,393 Patented May 14, 1963

3,089,393

DRIVE MECHANISM FOR FOLDING BOX MACHINES OF THE PLUNGER AND DIE TYPE

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Filed Mar. 13, 1962, Ser. No. 179,300
10 Claims. (Cl. 93—51)

This invention relates to improvements in folding box forming machines of the type in which a box forming plunger folds a box blank into box shape by forcing it into a folding die. If the box is of the glued type, the folding die is momentarily contracted to exert a compressive force on the glued box which is internally supported by the plunger. During the period of compression the plunger must be at rest, but it is desirable to maintain other portions of the machine, for example the blank feeder, in continuous operation.

The patent to Hoyrup 2,997,928, dated August 29, 1961, discloses a drive mechanism for a box forming machine of the aforementioned kind in which a force and motion transmitting coupling is installed between the plunger and a continuously operating driving member. The coupling permits the plunger to come to rest during the box compression period, while the remanider of the machine continues in motion. In addition, the coupling imparts desirable motion and velocity characteristics to the plunger which differ from those of the continuously oscillating drive bar and which are particularly desirable, if the box blank consists of tough paperboard requiring temporarily a relatively high peak energy for folding the flat blank.

The Hoyrup coupling disclosed in the aforementioned patent employs the compressive force of air both for the work stroke during which the plunger moves into the die, as well as for the return stroke during which the plunger is withdrawn from the die.

In box machines of the universal type, i.e, built to form boxes of a variety of sizes, as distinguished from machines built to form one size or a narrow range of box sizes only, it is necessary to install a heavy plunger at one time, and a light plunger at another time. The weight of the plunger determines its momentum and the momentum, in turn, affects the motion characteristics. Assuming, for example, that a heavy plunger is employed, an unusually high air pressure is created in the air cylinder which operates to withdraw the plunger from the die. The pressure is particularly high if the machine is operated at a high rate of speed. As a result, high temperatures are experienced and chattering may occur evidenced by uneven and non-uniform acceleration of the plunger. To correct such behavior an adjustment of the air feeder passages of the pneumatic system is required which, although routine to a mechanic familiar with the characteristics of the machine, may require time consuming experimentation by personnel in a box maker's plant less intimately familiar with machines of this type.

This invention and improvement is based on the discovery that a pneumatic variable volume chamber device in combination with a hydraulic variable volume chamber device disposes of the existing difficulties and makes it unnecessary to adjust the force and motion transmitting device or coupling for different plunger weights.

Variable volume chamber devices may assume different forms, the most suitable forms being basically the bellows type and the cylinder and piston type. Use of a bellows or of multiple diaphragm capsules is generally only advisable where the stroke is relatively small. A short multiple diaphragm or bellows stroke may, of course, be multiplied by suitable lever devices.

The cylinder and piston type may have the form of the familiar straight line cylinder and piston arrangement, but may also be of the rotary design in which a pivoted vane-piston divides a substantially sector shaped cylinder into two chambers.

The choice of the specific form of cylinder and piston arrangement depends on the construction of the machine and the availability of space. The invention will be illustrated as applied to a box machine in which the straight line cylinder and piston is the most convenient form of motion and force transmitting device.

The various objects, features and advantages of this invention will appear more fully from the detailed description which follows accompanied by drawings snowing, for the purpose of illustration, a preferred embodiment of the invention. The invention also resides in certain new and original features of construction and a combination of elements hereinafter set forth and claimed.

Although the characteristic features of this invention which are believed to be novel will be particularly pointed out in the claims appended hereto, the invention itself, its objects and advantages, and the manner in which it may be carried out may be better understood by referring to the following description taken in connection with the accompanying drawings forming a part of it, in which:

FIG. 1 is a diagrammatic drawing illustrating certain portions of the plunger and die mechanism and portions of the drive;

FIG. 2 is a perspective view of the plunger drive incorporating the invention;

FIG. 3 is a perspective view of the mechanism during a different phase of its operation; and

FIG. 4 is a vertical cross sectional view of the pneumatic and the hydraulic portions of the mechanism.

In the following description and in the claims various details will be identified by specific names for convenience. The names, however, are intended to be generic in their application. Corresponding reference characters refer to corresponding parts in the several figures of the drawings.

The drawings accompanying, and forming part of, this specification disclose certain specific details of construction of the invention for the purpose of explanation of broader aspects, but it is understood that constructional details may be modified in various respects without departure from the principles of the invention and that the invention may be incorporated in other structural form than shown.

FIG. 1 shows a box blank **11** having a main panel M, end panels E, side panels S and glue flaps F underneath a plunger **12** and above a die **13**. The die is a combined folding and compression die and comprises front and rear blank folding elements **14** and **15** adapted to engage the side panels S and fold the side panels against the sides **18** and **19** of the plunger **12**.

Further blank folding elements **16** and **17** are adapted to engage the end panels E to fold these against the end surfaces **20** and **21** of the plunger **12**. Glue applicators **22** and **23** are provided at the four corners of, and slightly above, the die **13**. The two glue applicators nearest the observer are omitted for the sake of clarity.

The glue applicators prefold the flaps F at an angle to the side panels S and apply adhesive to the outside of the flaps so that upon entry of the blank into the die the flaps F overlie the end surfaces **20** and **21** of the plunger and the end panels E lie thereover and become adhesively secured thereto.

A pair of pressure plates **24** and **25** are linked to power levers **26** and **27** at **28** and **29**. One end of the levers is pivotally supported at **30** and **31** and a hydraulic servo-motor **32** is pivotally connected to the opposite end of the power levers at **33** and **34**. The piston **35** of the servo-motor subdivides the servo-motor cylinder **36** into

a left chamber **37** and a right chamber **38**. Pressure lines **39** and **40** lead to the chambers of the servo-motor. Fluid under pressure entering the left chamber **37** through the line **39** causes the power levers **26** and **27** to be drawn together and the plates **24** and **25** to exert compressive force on a folded box moved into the die by the plunger **12**.

FIG. 1 also shows in simplified form the major elements of the drive mechanism comprising an electric motor **41** having a pulley **42** which drives a gear **43** on a pinion shaft **44** through a chain **45**. A pinion **46** on shaft **44** meshes with a gear **47** on a crank shaft **48** carrying a crank **49**. The crank is linked to an oscillating arm **50** by a connecting rod **51**. The oscillating lever oscillates about a fixed pivot **52** and the free end of the arm **50** is linked to a reciprocating cross head **53** by a further connecting rod **54**. The cross head is slidably supported on a column **55** and supports one end of a drive bar **56** whose other end is supported in a similar cross head **57** on the opposite side of the machine. The drive bar supports the plunger **12** in a manner later to be described.

The motor is supplied with power from a source **58** and controlled by switches **59** and **60**. The first switch **59** is operated by a cam **61** on the crank shaft **48**. The shape of the cam is such that the switch **59** opens whenever the drive bar **56** approaches the lower end of the down stroke at which moment the plunger **12** enters the die **13**. This would stop the machine were it not for the presence of a second switch **60** which then closes and maintains the circuit unbroken. The second switch, as will later be seen, is operated by a cam **62** moving with the plunger **12**. The purpose of this arrangement is to stop the machine if for any reason the plunger is prevented from entering the die.

The foregoing description covers the essential elements of the driving mechanism in a simplified combination of assembly. In actual practice the mechanism is somewhat more complex and refined and comprises, for example, means for varying the speed of the drive, relay control mechanisms in the electric circuit, and other details not essential to an understanding of the present invention. These details are disclosed in the patent to Edward J. Pagendarm.

The plunger drive bar **56** carries two bracket **63** and **64** on which a common base plate **65** is mounted. The base plate carries two vertical cylinders **66** and **67**. The cylinder **66** is a pneumatic cylinder and contains a piston **68** whose piston rod **69** extends through the top of the cylinder to a piston plate **70**.

The piston **68** divides the cylinder **66** into an upper chamber **71** and a lower chamber **72**. The upper chamber **71** is vented to the atmosphere through a duct **73** and an air filter and silencer **74**, and the lower chamber **72** comprises a passage **75** leading to a check valve **76**. The check valve is so oriented as to seal the passage **75** while subatmospheric pressure exists in the chamber **72**, but to open the passage to vent above atmospheric pressure in the chamber.

This arrangement limits the range of pressures which may exist within the chamber **72** to a maximum of atmospheric pressure and a minimum approaching vacuum. If desired, a restricted passage may be provided parallel to the check valve **76**, for example in the form of a needle valve as disclosed in the aforesaid Hoyrup patent. Such a by-pass operates to limit the degree of vacuum which may be created in the chamber **72**.

The hydraulic cylinder **67** represents an enclosure within which an inner cylinder **77** is mounted. The upper end of the inner cylinder **77** is fitted with a guide bushing **78** of synthetic plastic such as nylon or tetrafluoroethylen polymer plastic also known by the name "Teflon."

The lower end of the inner cylinder is normally closed by a check valve comprising an annular valve member **79** urged in an upward direction by a helical spring **80**. The valve member **79** normally closes a plurality of passages **81** leading to an annular space **82** between the inner and the outer cylinders **77** and **67**, respectively. This space **82** is filled with a hydraulic liquid extending to a level **83** controlled by a filler plug **84**.

The piston cooperating with the cylinder **77** preferably has the form of a rod **85** having a lower portion **86** of reduced cross section. This may be accomplished by longitudinal flutes in a cylindrical lower portion, but is more conveniently accomplished by tapering the lower portion **86** slightly.

As the rod enters the bore **87**, the liquid in the cylinder tries to escape and encounters a progressively increasing flow resistance as the escape passage between the rod portion **86** and the cylinder **77** becomes progressively longer and narrower. During entry of the rod piston **86** into the cylinder bore **87** the check valve remains closed.

The disk shaped valve member **79** has a central bore **88** and the liquid pressure acting on the underside of the valve member **79** keeps the valve tightly closed, supplementing the closing force of the spring **80**.

The space of the cylinder **67** above the liquid level **83** is vented to the atmosphere. This may be accomplished by a vent passage **73**.

The rod piston **85**, **86** is longitudinally adjustable in the piston plate. For this purpose the upper portion of the rod **85** is threaded at **89** and fitted with knurled nuts **90** and **91**.

The tops of the cylinders are connected by a tie plate **92** on which two compressible buffers **93** and **94** are mounted composed of rubber or other suitable material. Buffer **94** cooperates with the knurled adjustment nut **91** and a corresponding cylindrical element is mounted on the piston rod **69**. The buffers **93**, **94** and elements **91**, **91** limit the extent to which the pistons **68**, **86** may be moved into the cylinders **66** and **77**.

Two plunger rods **95** and **96** extend downwardly from the piston plate **70** and are guided in slide bushings **97** and **98** in the tie plate **92**. Similar bushings in the base plate **65** are not visible in the figures. The plunger rods terminate at a plunger plate **99**. The plunger **12** is attached to the plunger plate by a bolt **100** and is aligned with respect to the plunger plate by appropriate dowel pins (not visible). In FIGS. 2 and 3 certain elements shown in FIG. 1 are removed from the die assembly **13** for the sake of clarity.

It was previously mentioned that the downward motion of the plunger **12** is arrested in the position in which compressive force is exerted on the folding box by the die **13**.

A hydraulic snubber mechanism is provided for this purpose comprising a snubber **101** mounted on the framework on the machine and a striker pad **102** on the piston plate **70**.

The snubber comprises a cylinder **103** containing a piston **104** having a narrow groove or passage **105** through which fluid may pass from a lower chamber **106** of the body **107** into an upper chamber **108**. The upper chamber **108** is a reservoir for the liquid **109**. The piston **104** is under the action of a spring **110** tending to maintain the piston **104** raised. When the piston is depressed it offers increasing resistance to displacement due to the fact that the flow resistance of the passage **105** between the lower chamber **106** and the upper chamber **108** increases. The increasing resistance offered by the snubber arrests the plunger gently.

When the plunger reaches its lowest position and is arrested, the pressure plates **24** and **25** are urged together. As a result the plunger is temporarily clamped between the plates and rendered immovable while compressive force is being exerted on the glued ends of the box carried by the plunger.

The drive bar **56** of the plunger may start its upward stroke without delay while the plunger proper stays in place until the compressive force of the plates **24** and **25** is released. During the upward motion of the bar **56** the cylinders **66** and **67** move in an upward direction with respect to their pistons which are at rest by reason of

being attached to the plunger. During the upward motion the rod piston **85** enters the inner cylinder **77** at about the moment the die **13** is expanded to release the plunger **12**. Liquid pressure is being built up in the inner cylinder **77** from which the liquid is permitted to escape at a slow controlled rate past the tapered portion **86** of the rod piston **85**. The force exerted by the upwardly moving cylinder **77** on the rod piston **85** drives the latter in an upward direction and at a gradually accelerating rate which towards the end of the upward return stroke becomes substantially equal to the rate of motion of the cylinder **77** and the drive bar **56**.

During the return stroke the volume of the pneumatic chamber **72** is also reduced and excess air which may have entered it is expelled through the check valve **76**.

When the drive bar **56** reaches the top of its stroke the plunger **12** and its piston assembly **68, 85, 70, 95, 96** continues its upward motion for a certain short distance until the vacuum in the chamber **72** and the weight of the plunger become powerful enough to reverse the plunger. At the point of reversal of the plunger partial vacuum exists in the chamber **72** causing the plunger to be driven downwardly to perform its work stroke.

During the work stroke atmospheric pressure acting on the top side of the piston **68** drives the piston downward inside the cylinder **66**. This downward motion is unrestrained during the initial portion of the stroke and is restrained or controlled as soon as the rod piston **86** enters the inner cylinder **77** of the hydraulic unit.

During the initial phase of the work stroke the rod piston **86**, which immediately prior to this moment extended into the hydraulic inner cylinder **77**, is being withdrawn therefrom. Liquid then enters the cylinder **77** through the bottom check valve **79, 81** and is being withdrawn from the annular liquid storage space **82**.

The plunger comes to rest at its lowest point when its striker pad **102** meets the snubber **101**.

During the lower portion of the downstroke the plunger cam **62** actuates the switch **60** which closes and maintains the drive circuit unbroken during the phase of the operation during which the switch **59** opens.

If the downstroke of the plunger **12** is obstructed, for example by accidental feeding of several cohering blanks or some other obstacle in the path of the plunger, the pneumatic mechanism permits the drive bar **56** to continue moving until the entire drive mechanism is stopped immediately thereafter due to failure of the plunger switch **60** to close.

Obviously structural details of the yielding drive mechanism may be modified in various respects to fit the requirements of the individual installations.

What is claimed is:

1. In a folding box forming machine in which a reciprocating drive means moves a box shaping plunger into a forming die during a work stroke and out of the forming die during a return stroke, an improved force and motion transmitting coupling between the drive means and the plunger comprising: a pneumatic variable volume chamber means and a hydraulic variable volume chamber means including a charge of liquid therein, said pneumatic means comprising a passage to the atmosphere, and passage control means arranged to close said passage during the work stroke sufficiently to cause a difference in air pressure to build up in the chamber with respect to the atmosphere and to vent the chamber pressure to the atmosphere during the return stroke, said hydraulic means comprising a restricted liquid charge passage and being arranged to undergo compression and discharge of liquid during the return stroke.

2. In a folding box forming machine in which a reciprocating drive means moves a box shaping plunger into a forming die during a work stroke and out of the forming die during a return stroke, an improved force and motion transmitting coupling between the drive means and the plunger comprising: a pneumatic variable volume chamber means and a hydraulic variable volume chamber means including a charge of liquid therein, said two chamber means being arranged in parallel, said pneumatic means comprising a passage to the atmosphere and a check valve in said passage arranged to close the passage during the work stroke to a degree sufficient to cause a difference in air pressure to build up in said chamber with respect to the atmosphere, and to vent the chamber to the atmosphere upon reversal of the pressure during the return stroke, said hydraulic means comprising a restricted liquid discharge passage and being arranged to experience compression during the return stroke and discharge of liquid through said restricted liquid passage.

3. In a folding box forming machine in which a reciprocating drive means moves a box shaping plunger into a forming die during a work stroke and out of the forming die during a return stroke, an improved force and motion transmitting coupling between the drive means and the plunger comprising: a pneumatic variable volume chamber means and a hydraulic variable volume chamber means including a charge of liquid therein, said pneumatic means comprising a passage to the atmosphere, and passage control means arranged to close said passage during the work stroke sufficiently to cause a difference in air pressure to build up in the chamber with respect to the atmosphere and to vent the chamber pressure to the atmosphere during the return stroke, said hydraulic means comprising a restricted liquid discharge passage and being arranged to undergo compression and discharge of liquid during the return stroke of said plunger; and motion limiting stop means in parallel with said hydraulic means to become effective during the return stroke after displacement of a certain volume of liquid through said last named passage to render said hydraulic means ineffective during the remainder of the return stroke.

4. In a folding box forming machine in which a reciprocating drive means moves a box shaping plunger into a forming die during a work stroke, and out of the forming die during a return stroke, an improved force and motion transmitting coupling between the drive means and the plunger comprising: a pneumatic first cylinder; a first piston movable relatively to said first cylinder; a hydraulic second cylinder including a charge of liquid therein; a second piston movable relatively to said second cylinder, said first and said second cylinder and piston being arranged in parallel; first air flow control means for said first cylinder and piston, said first air flow control means including an air passage between said first cylinder and the atmosphere, said control means being arranged substantially to seal said air passage during the work stroke, and to open said passage during the return stroke; and second liquid flow control means for said second cylinder and piston, said second control means being arranged to provide low flow resistance to the liquid during the work stroke and high flow resistance during the return stroke.

5. The combination as set forth in the preceding claim 4 in which said second flow control means comprises means for gradually increasing the liquid flow resistance during the progress of the return stroke.

6. In a folding box forming machine in which a reciprocating drive means moves a box shaping plunger into a forming die during a work stroke, and out of the forming die during a return stroke, an improved force and motion transmitting coupling between the drive means and the plunger comprising: a pneumatic first cylinder; a first piston movable relatively to said first cylinder; a hydraulic second cylinder including a charge of liquid therein; a second piston movable relatively to said second cylinder, said first and said second cylinder and piston being arranged in parallel, the said first cylinder and piston defining a chamber in which vacum is created during the work stroke, said second cylinder and piston defining a chamber in which pressure is created during the

return stroke; air flow control means including an air passage between said vacuum chamber and the atmosphere; a check valve in said air passage for closing the passage during vacuum and opening the passage to vent above atmospheric pressure; liquid flow control means for said second cylinder and piston, said liquid flow control means being arranged to provide low flow resistance to liquid into said second cylinder during the work stroke, and a higher flow resistance to liquid from said second cylinder during the return stroke, said second control means including means for varying the flow resistance in dependence on the position of said second piston relatively to said second plunger during the return stroke.

7. In a folding box forming machine in which a reciprocating drive means moves a box shaping plunger into a forming die during a work stroke, and out of the forming die during a return stroke, an improved force and motion transmitting coupling between the drive means and the plunger comprising: a first end member; a second end member, one of said end members being adapted to be connected to said drive means, the other end member being adapted to be connected to the plunger; a pneumatic first cylinder mounted on said first end member; a first piston mounted on said second end member, said first piston being movable in said first cylinder and dividing the first cylinder into two chambers; air passage control means comprising means forming an air passage between one of said chambers and the atmosphere and a check valve therein to restrict flow of air between said chamber and the atmosphere to a greater degree in one direction than in the opposite direction; a second cylinder mounted on said first member and constituting an outer cylinder; an inner cylinder mounted within said outer cylinder; a charge of liquid in said outer cylinder, said liquid occupying the space between said inner and outer cylinders; a second piston mounted on said second end member in a position to be movable into and out of said inner cylinder, said second piston having a loose fit with respect to said inner cylinder to permit fluid to escape past said second piston when said second piston enters said inner cylinder; and a check valve between the interior space of said inner cylinder and the space between said inner and outer cylinder, said last named check valve being oriented to open when as a result of withdrawal of said second piston the pressure in said inner piston is reduced.

8. The combination as set forth in the preceding claim 7 in which said second piston has the form of a tapered rod for gradually increasing the flow resistance to liquid flowing from said inner cylinder as the rod passes into said inner cylinder.

9. In a folding box forming machine in which a reciprocating drive means moves a box shaping plunger into a forming die during a work stroke, and out of the forming die during a return stroke, an improved force and motion transmitting coupling between the drive means and the plunger comprising: a first cylinder and piston forming a pneumatic chamber and arranged to create vacuum in said chamber during the work stroke; a second cylinder and piston forming a hydraulic chamber; a charge of liquid in said hydraulic chamber, said second cylinder and piston being arranged to undergo compression during the return stroke; passage forming means through which liquid may flow from the hydraulic chamber during the return stroke, and into said hydraulic chamber during withdrawal of the second piston from the cylinder during the work stroke; and flow control means associated with said passage means for subjecting liquid flow from the hydraulic chamber to greater resistance than liquid flow into the chamber.

10. In a folding box forming machine in which a reciprocating drive means moves a box shaping plunger into a forming die during a work stroke, and out of the forming die during a return stroke, an improved force and motion transmitting coupling between the drive means and the plunger comprising: a first cylinder and piston forming a pneumatic chamber and arranged to create a difference in pneumatic pressure within said chamber in relation to the atmosphere during the work stroke; a second cylinder and piston forming a hydraulic chamber; a charge of liquid in said hydraulic chamber, said second cylinder and piston being arranged to undergo compression during the return stroke; passage forming means through which liquid may flow from the hydraulic chamber during the return stroke, and into said hydraulic chamber during withdrawal of the second piston from its cylinder during the work stroke; and flow control means associated with said passage means for subjecting liquid flow from the hydraulic chamber to greater resistance than liquid flow into the chamber.

No references cited.