United States Patent [19]

Vinson

[11] **3,712,163**

[45] **Jan. 23, 1973**

[54] **SHUTTLE PRESS**

[75] Inventor: **Paul Vinson,** Orange, Calif.

[73] Assignee: **Vinson Industries, Inc.,** Orange, Calif.

[22] Filed: **June 15, 1970**

[21] Appl. No.: **46,009**

[52] **U.S. Cl.** **83/206,** 83/50, 83/255, 83/277, 83/282

[51] **Int. Cl.** **B26d 5/20**

[58] **Field of Search**.....83/39, 40, 50, 55, 206, 255, 83/276, 277, 282

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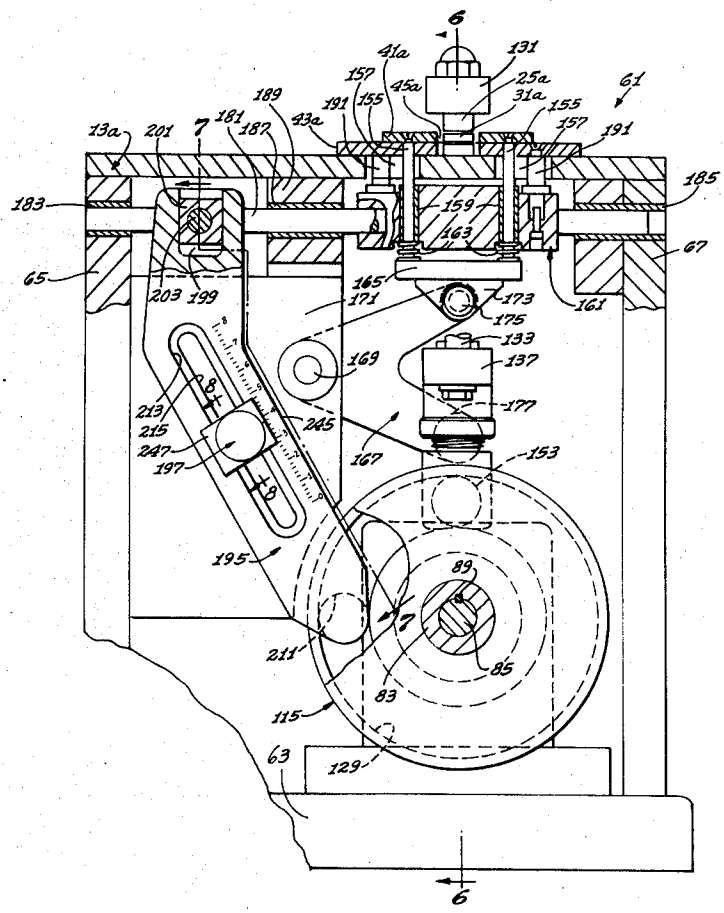
[57] **ABSTRACT**

A press for performing work operations on sheet material having at least one work station at which such work operations are performed. The press includes a pair of secondary pads for retaining the material in position. The secondary pads are movable in a shuttle or reciprocating type motion to progressively and intermittently feed the sheet material through the work station.

16 Claims, 19 Drawing Figures



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SHEET 1 OF 6

Fig. 1

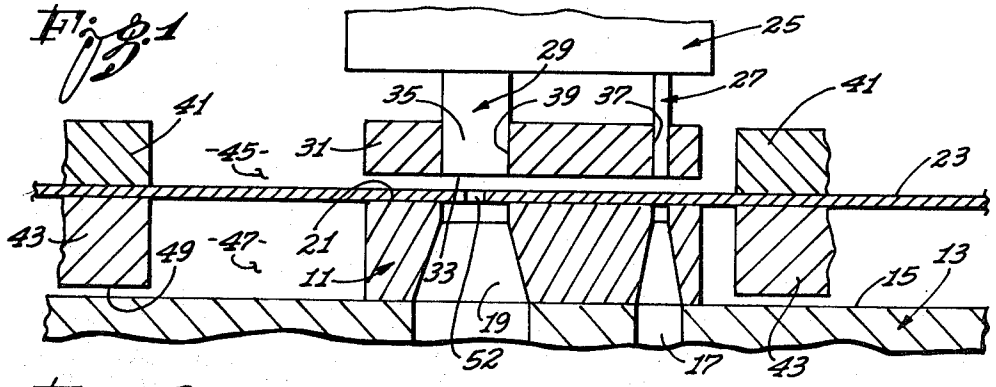

Fig. 2

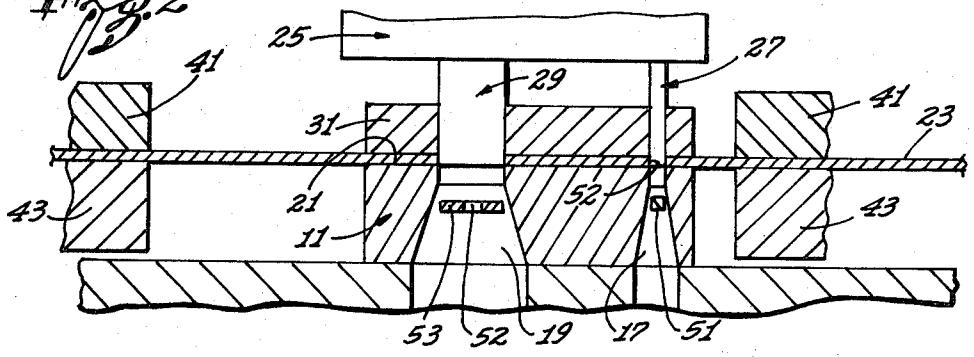

Fig. 3

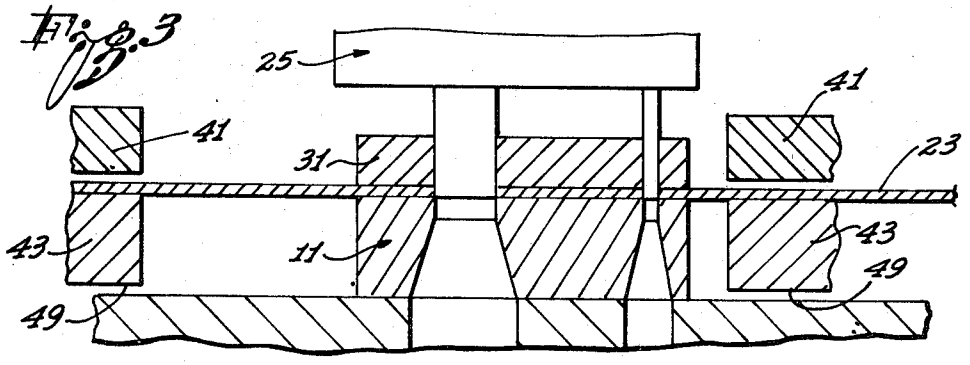

Fig. 4

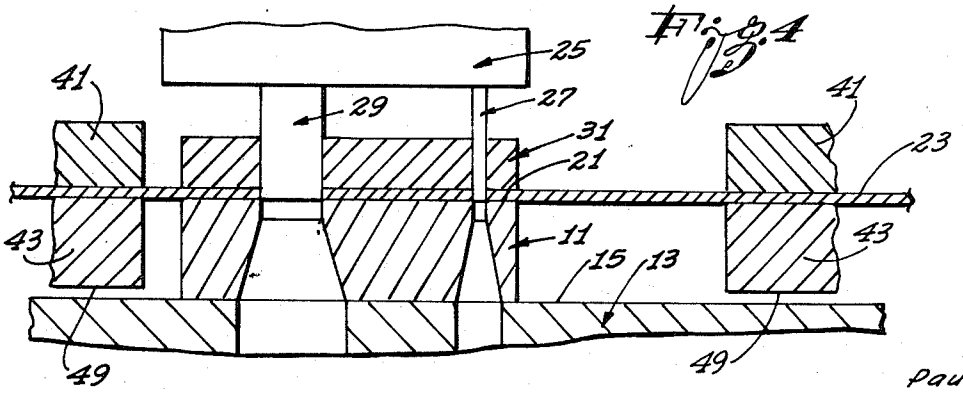

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Fig. 5

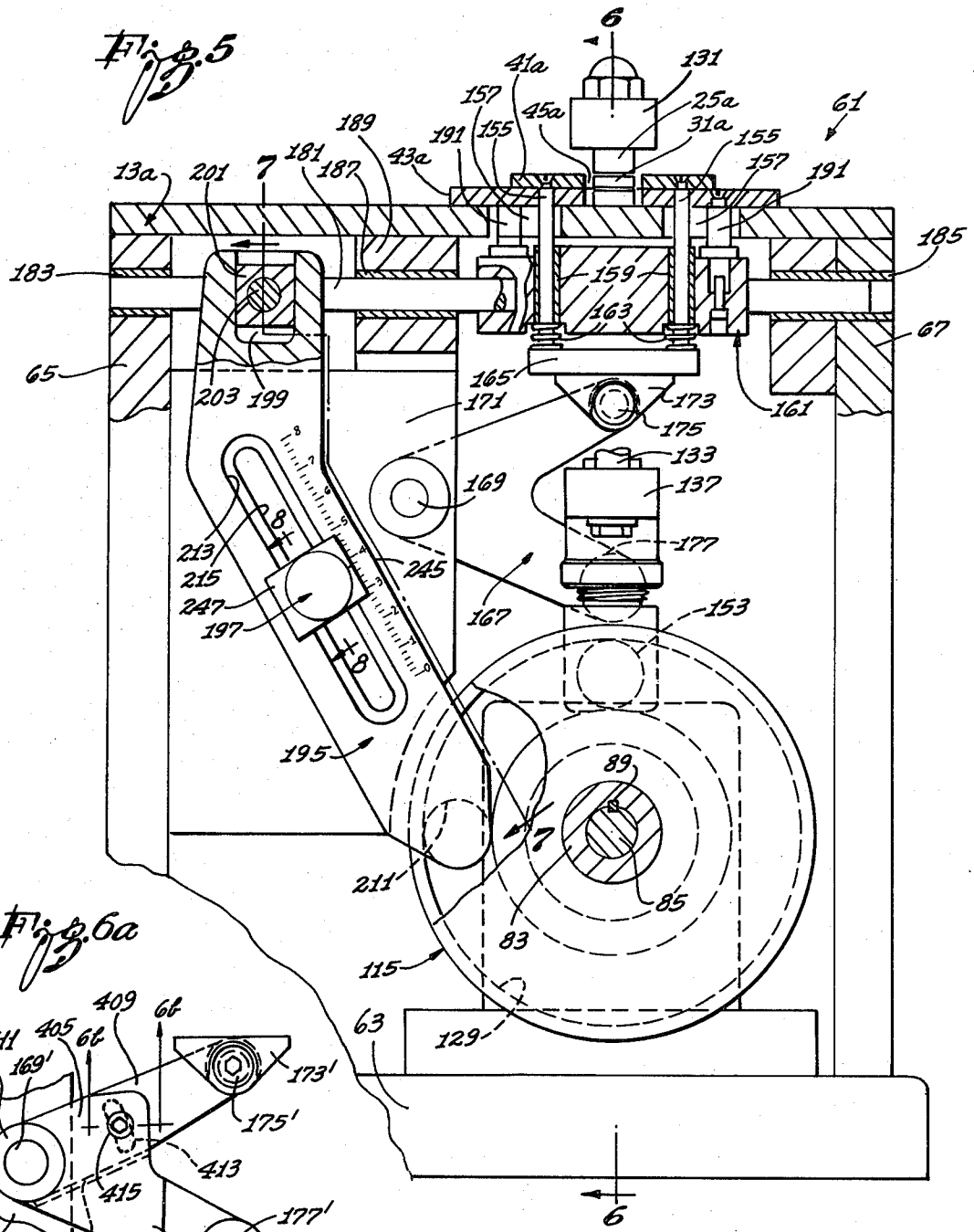

Fig. 6a

Fig. 6b

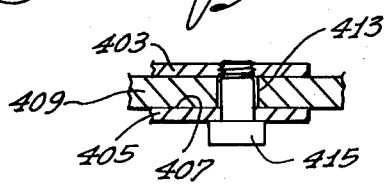

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Fig. 6

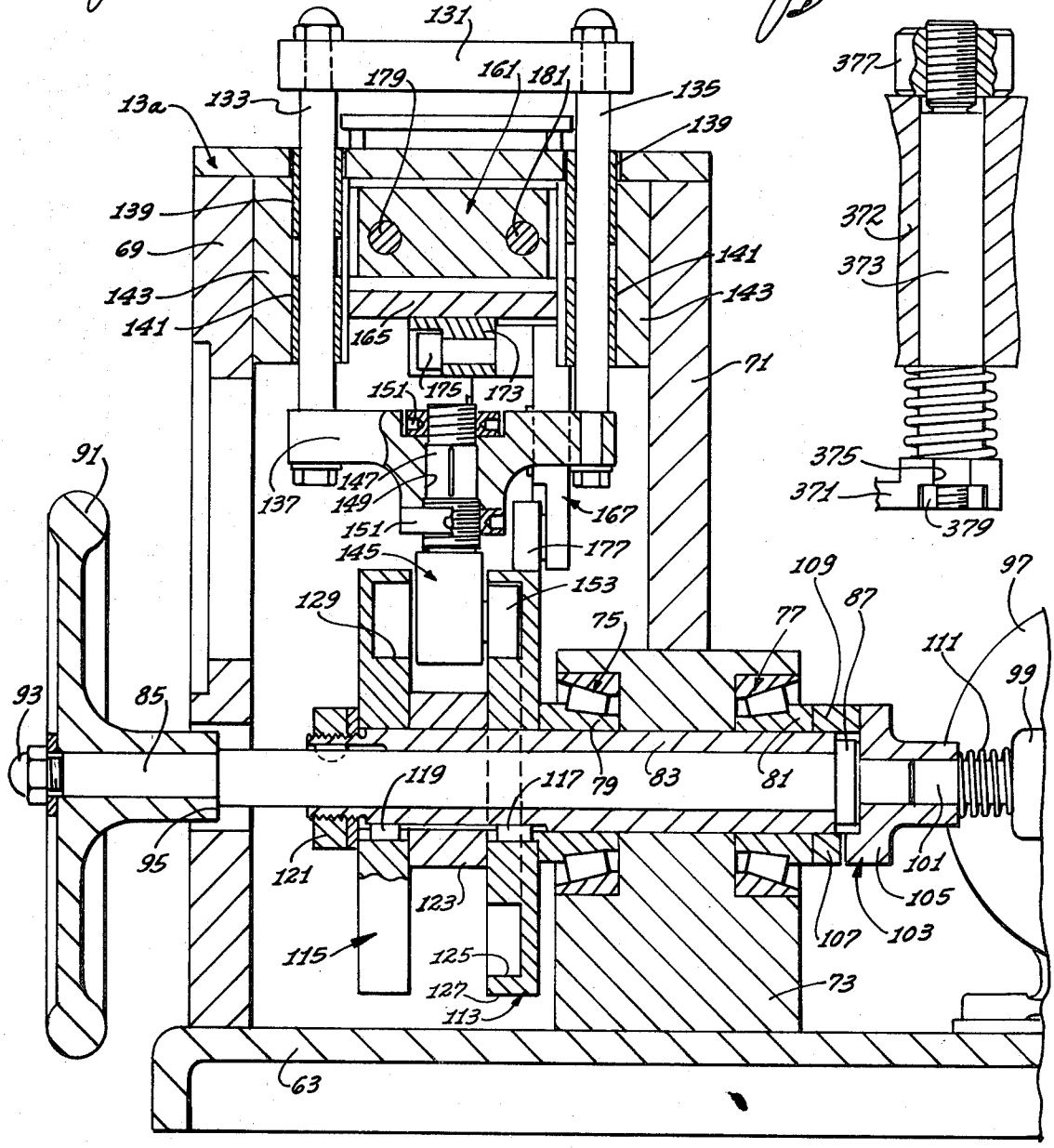

Fig. 15

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Fig. 7

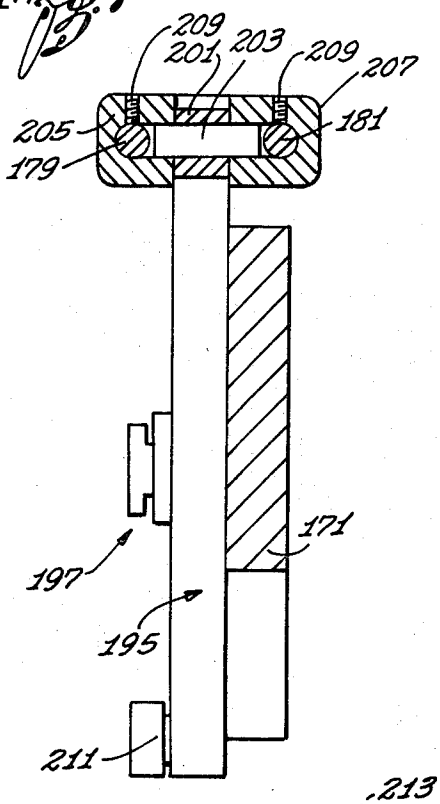

Fig. 8

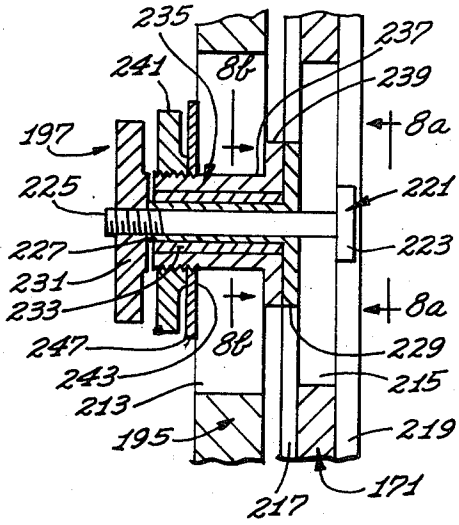

Fig. 8a

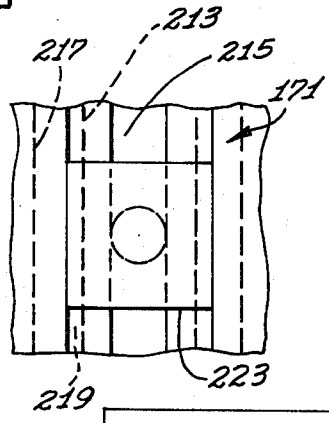

Fig. 8b

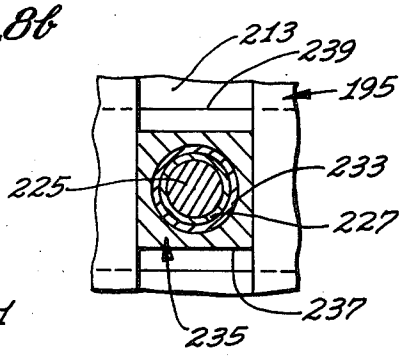

Fig. 9

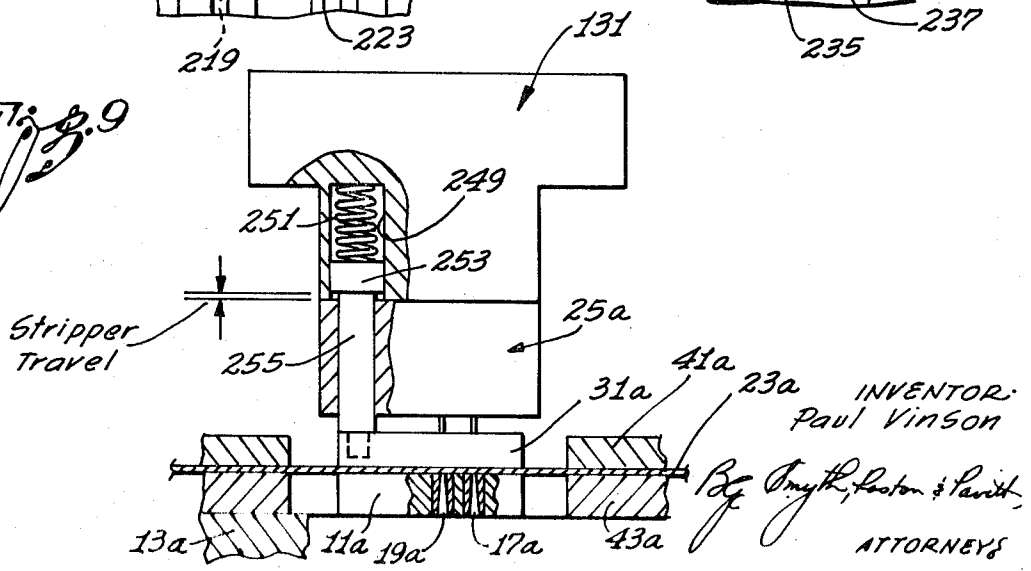

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Fig. 10

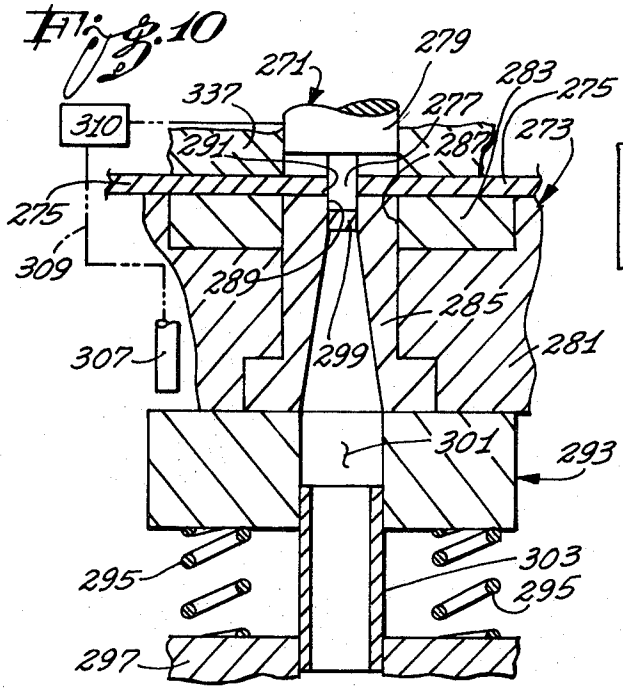


Fig. 11

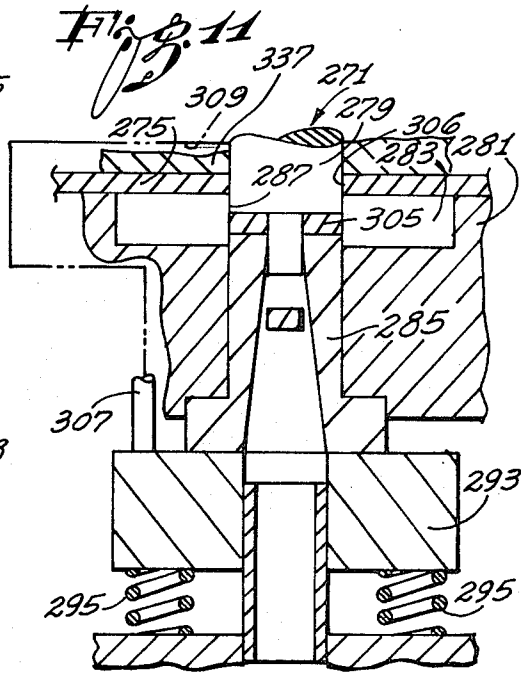


Fig. 13

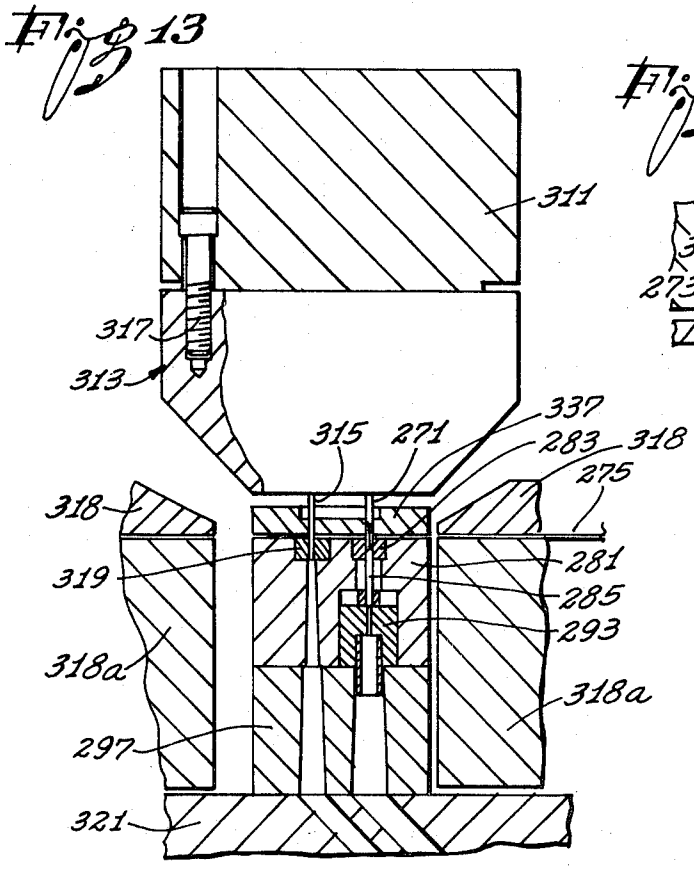
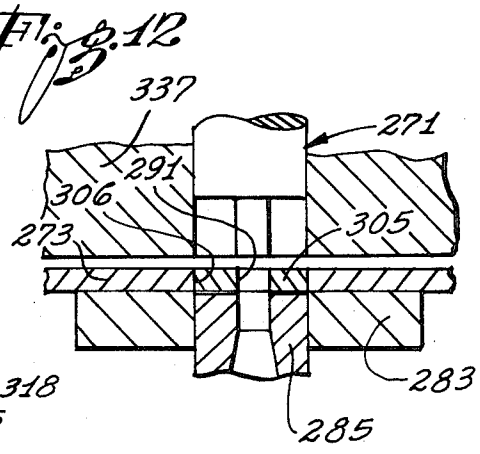


Fig. 12



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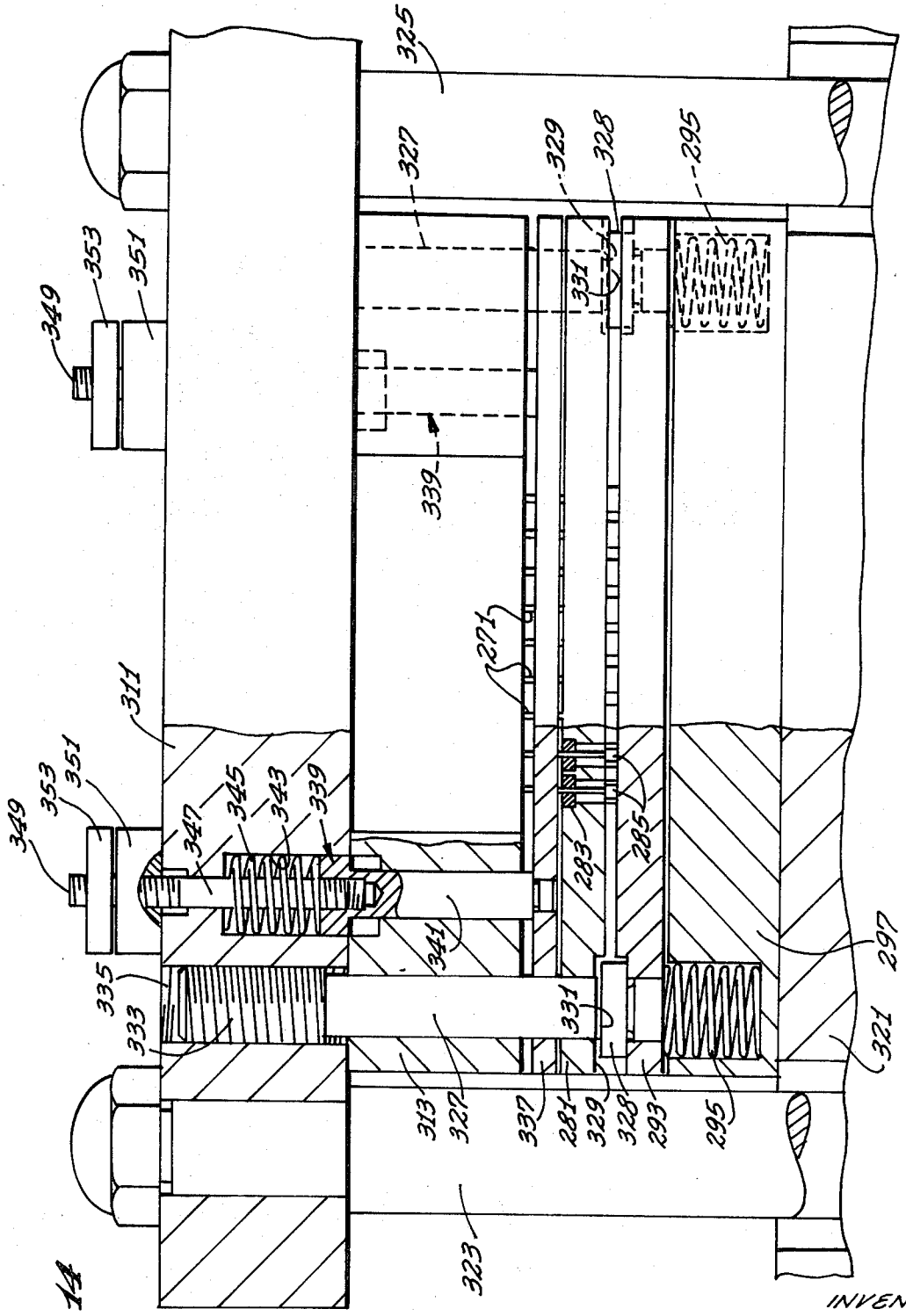

Fig. 14

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SHUTTLE PRESS

BACKGROUND OF THE INVENTION

Many parts are fabricated from sheet material of various kinds such as aluminum, steel, tape, ceramics, etc. The fabrication of the part typically includes progressively and intermittently feeding the sheet material through several stations of the press with one work operation being performed at each of the stations by appropriate tooling and with the completed part being blanked out at the last station.

It is conventional practice to use automatic feeding mechanisms such as roll or hitch feeds to move the sheet material through the several stations. These feeding mechanisms are not part of the press and are expensive. The typical feed mechanism does not index the sheet material through the stations as accurately as necessary for many precision operations. The feeding mechanism is typically remote from the station at which the work operations are performed and reacts relatively slowly so that the speed of stock feeding consumes a relatively large amount of time.

For example, a roll feed roughly indexes the sheet material and bullet nose pilot punches cooperate with preformed apertures in the sheet material to finally align the sheet material with the tooling. This requires a special work operation to preform the apertures and because of allowable tolerances between the pilot punches and the preformed apertures, the final positioning of the sheet material is not as accurate as is necessary or desirable for many work operations. In addition there is an interval of time when the sheet material is not held in position by the toll feed or the pilot punches.

Many presses are not accurate notwithstanding the manner of stock feed. The recognition of the factors causing such inaccuracy and their solution form a part of the present invention.

In an effort to increase accuracy, it is customary to employ a die set on the press. While this does improve accuracy, equipment cost and set up time are increased.

My copending application Ser. No. 33,592 entitled Shuttle Press filed on May 1, 1970, now U.S. Pat. No. 3,673,901, discloses a press having numerous advantageous features including a shuttle for accurately and rapidly feeding sheet material through the press. In the invention described in the copending application, one of the tools for performing a work operation on the sheet material interlocks with the sheet material. This tool is movable in a shuttle type motion to feed the sheet material through the press.

While the invention of my copending application represents a very substantial improvement over the prior art, it is especially adapted for a press with up to two work stations. In addition, it leaves some possibilities for increasing speed of operation because one of the tool members is involved in the work operation, the stock transfer and the return shuttle movement.

SUMMARY OF THE INVENTION

The present invention eliminates the problems described above. One aspect of the present invention is to employ a shuttle which is part of the press itself for feeding the sheet material through the press. The shuttle is closely adjacent the stations of the press at which

the work operations are to be performed. The shuttle eliminates the expensive automatic feeding mechanisms used heretofore and provides a much more rapid and accurate feed. Pilot punches and die sets are not necessary with the present invention.

The shuttle concept involves the use of one or more shuttle members which are drivingly engageable with the stock to move the stock a distance corresponding to the distance between adjacent work stations. The shuttle can then be returned to its initial position and caused to impart a second increment of movement to the sheet material in the same manner. Operation of the shuttle is appropriately coordinated with the operation of the tooling and the other parts of the press.

Although the shuttle concept can be implemented in different ways, according to the present invention it is preferred to utilize a portion of the means for retaining the sheet material in position to feed the sheet material through the press. Secondary or shuttle pads are employed to grip or clamp the sheet material and the shuttle pads are movable in a shuttle or reciprocating type motion to intermittently and progressively feed the sheet material through the press.

The shuttle pads are preferably operated by means other than the platen. Accordingly, the platen need not travel with the sheet material and can reciprocate vertically in a predetermined timed relationship to the rate of indexing of the sheet material. Thus, the press can have any number of work stations without in any way slowing down the operation of the press.

During the performance of a work operation on the sheet material, the shuttle pads clamp the sheet material in position. Following the work operation or near the completion thereof, the shuttle pads unclamp the sheet material and move to a new position at which the shuttle pads again clamp the sheet material. The shuttle pads then move to index the sheet material.

During the time the shuttle pads are not clamping the sheet material, the sheet material is retained in position by suitable means such as a primary pressure pad which is operatively associated with the platen. Accordingly, the primary pad and the shuttle pads cooperate to tightly retain the sheet material in position throughout the full operational cycle of the press and accordingly the accuracy of the press is very good.

To reduce frictional losses, the shuttle pads do not slidably engage other portions of the press during the reciprocating movement thereof.

Although the movement of the shuttle pads can be implemented in different ways, it is preferred to use a carriage beneath the shuttle pads. The carriage is mounted for movement along a first path which may be in a plane parallel to the plane of the sheet material. The carriage and the shuttle pads are drivingly connected for movement of the shuttle pads with the carriage along such first path. At least one of the shuttle pads is mounted for movement relative to the carriage along the second path, and this permits the pads to clamp and unclamp the sheet material. Movement of the carriage along the first path provides the stock feeding and pad return movement. These movements can be coordinated by suitable cams.

Numerous other factors contribute to the speed and accuracy of the press of this invention. For example, substantially all of the press is located at elevation

beneath the platen thereby lowering the center of gravity of the press and tending to stabilize it. The platen and the shuttle pads are mounted on suitable posts which extend downwardly from the platen with each of the posts being supported by relatively long bearings. To further improve the speed of the press, the platen and shuttle pads are preferably driven by full harmonic cams which are much faster than an eccentric. The cams can be changed to thereby permit full programming of the operations performed by the press.

According to the present invention, it is preferred to move the carriage along a line generally parallel to the plane of the sheet material utilizing a cam and an arm mounted for pivotal movement about a pivotal axis. The length of stroke of the carriage can be varied by moving of the pivot axis of the arm while holding the arm in position.

Although the adjustable pivot may take many different forms, it is preferred to utilize a supporting member and to provide slots in both the arm and the supporting member. A supporting shaft extends through both of the slots and bearing means is mounted on the supporting shaft for mounting the arm on the shaft for pivotal movement relative to the supporting shaft about a pivotal axis. Means are provided for releasably drivingly connecting at least a portion of the bearing means to the arm for pivotal movement therewith. The arm is releasably retained on the bearing means so that the bearing means and the supporting shaft can be moved in the slots relative to the arm and the supporting member to thereby move the pivot axis relative to both of the arm and the supporting member.

The press of this invention can be utilized to perform plural work operations in a single hit or stroke of the platen. To accomplish this the die preferably includes an outer die having an opening therein and an inner die for cooperation with a portion of the punch for performing a first work operation. The inner die is mounted for movement in the opening of the outer die.

As the toolholder and punch are moved downwardly toward the sheet material, the punch engages the sheet material and cooperates with the inner die to perform a first work operation. At about the time the first work operation is completed or subsequently thereto, a drive member, other than the punch, urges the inner die downwardly to thereby allow a second portion of the punch to cooperate with the opening in the outer die to perform a second work operation on the sheet material. The inner die is forced out of the way by the drive member so that the sheet material is not substantially squeezed between the outer die and the punch during the second work operation. If the punch itself were to move the inner die away, the sheet material may be coined somewhat between the punch and the inner die. The present invention eliminates this undesirable coining effect.

The present invention also provides for adjustment of the position of the primary pad relative to the platen. This is accomplished by utilizing adjustable connection means between the primary pad and the platen.

The invention, both as to its organization and method of operation together with further features and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying illustrative drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a sectional view showing tooling and shuttle pads constructed in accordance with the teachings of this invention with the tooling being in a position to cooperate to perform a work operation on the sheet material.

FIG. **2** is a sectional view similar to FIG. **1** with the tooling advanced to perform a work operation on the sheet material.

FIG. **3** is a sectional view similar to FIG. **2** with the upper shuttle pad raised slightly above the upper surface of the sheet material.

FIG. **4** is a sectional view similar to FIG. **3** after the shuttle pads have been moved to a new position along the sheet material and have again clamped the sheet material in preparation for indexing of the sheet material.

FIG. **5** is a side elevational view partially in section of a preferred form of press for carrying out work operations such as those shown in FIGS. **1–4**.

FIG. **6** is a sectional view taken generally along line **6—6** in FIG. **5** with some parts of the press being shown in front elevation.

FIG. **6*a*** is a side elevational view of another form of shuttle pad arm which is usable with the press of FIGS. **5** and **6**.

FIG. **6*b*** is a sectional view taken generally along line **6*b*—6*b*** of FIG. **6*a***.

FIG. **7** is an elevational view partially in section taken generally along line **7—7** of FIG. **5** and illustrating the arm which controls horizontal movement of the shuttle pads.

FIG. **8** is a sectional view taken generally along line **8—8** of FIG. **5** and showing a preferred mechanism for adjusting the location of the pivot axis of the arm which controls horizontal shuttle pad movement.

FIG. **8*a*** is a view taken generally along line **8*a*—8*a*** in FIG. **8**.

FIG. **8*b*** is a sectional view taken generally along line **8*b*—8*b*** in FIG. **8**.

FIG. **9** is a side elevational view partially in section of a platen, toolholder and tools which may be utilized in the press of FIG. **5**.

FIG. **10** is a fragmentary section view illustrating a modification of the invention in which a washer-like element is formed in a one-hit operation. In FIG. **10**, the punch is advanced sufficiently to have performed the first work operation on the sheet material.

FIG. **11** is a sectional view similar to FIG. **10** with the punch having been advanced to perform the second work operation.

FIG. **12** is a fragmentary sectional view showing how the inner die can be used to return the blanked out part to the remainder of the sheet material.

FIG. **13** is a sectional view through a preferred form of tooling for carrying out the work operations shown in FIGS. **10–12**.

FIG. **14** is a side elevational view partially in section of the preferred form of tooling shown in FIG. **13**.

FIG. **15** is a side elevational view showing a second form of primary pad adjustable means.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The concept relating to retaining and indexing of the sheet material through a work station can best be understood by reference to FIGS. 1–4. In FIG. 1, a die plate 11 is suitably fixedly mounted on a support member 13 having an upper surface 15. Although the construction of the die plate 11 will vary depending upon the number and type of work operations which are to be performed, in the embodiment illustrated the die plate 11 includes die cavities 17 and 19 located at first and second work stations, respectively. The size and cross sectional configuration of the die cavities 17 and 19 will depend upon the nature of the work operation which is to be carried out at the respective station; however, in the embodiment illustrated, the upper end portions of the cavities 17 and 19 are cylindrical with the portions therebelow flaring outwardly to facilitate slug or part removal.

The die plate 11 has an upper surface 21 against which sheet material 23 may rest. The sheet material 23 may be of any kind upon which it is desired to perform a work operation. For example, the sheet material 23 may be aluminum, steel, ceramic, precious metal, cloth, tape, etc.

A punchholder 25 which may be of any suitable construction, carries first and second punches 27 and 29 and a primary pressure pad 31. The punchholder 25 is suitably mounted for vertical movement toward and away from the die plate 11 and the punchholder is retained against horizontal movement. The primary pressure pad 31 is drivingly connected to the punchholder 25 for vertical movement therewith by a resilient driving connection which also permits relative vertical movement therebetween. Such driving connection between the punchholder 25 and the primary pressure pad 31 may be of the type described more fully hereinbelow with reference to FIG. 9.

The size and configuration of the punches 27 and 29 depend upon the type of work operations which it is desired to perform on the sheet material 23. In the embodiment illustrated, the punch 27 is a cylindrical piercing punch and the punch 29 has a cylindrical tip or end portion 33 and a cylindrical body 35 with the punch 29 being adapted to blank out a part. The punches 27 and 29 extend through cylindrical openings 37 and 39, respectively, in the primary pressure pad 31. Although the tooling is illustrated as including particular punches and die cavities, it should be understood that the invention is not limited to the use of any particular kind of tooling. Furthermore, the number of work stations illustrated in FIG. 1 as well as the number of punches and die cavities are merely illustrative.

The sheet material 23 is progressively and intermittently advanced through the work stations by an upper shuttle pad 41 and a lower shuttle pad 43. The shuttle pads 41 and 43 are mounted for movement horizontally in the plane of the sheet material 23 and the upper shuttle pad 41 is also mounted for vertical movement. A preferred form of mounting of the shuttle pads 41 and 43 is described more fully hereinbelow with reference to FIGS. 5–8.

In the embodiment illustrated, the shuttle pads 41 and 43 have openings 45 and 47, respectively, and the die plate 11 and the primary pad 31 are located within such openings. Thus, the pads 41 and 43 circumscribe the die plate 11 with portions of each of the pads being on opposite sides of the die plate. Although the pads 41 and 43 could be of different construction, preferably each of the pads is an integral unit in the sense that all portions thereof are rigidly affixed to each other to thereby assure accurate and uniform movement of the entire pad.

In the position shown in FIG. 1, the shuttle pads 41 and 43 clampingly engage opposite faces of the sheet material 23. Accordingly, with the pads 41 and 43 themselves firmly held in a fixed position, the sheet material 23 is also retained in such fixed position. The shuttle pad 43 has a lower face 49 which is spaced upwardly from the surface 15 of the support member 13 to thereby prevent frictional losses during horizontal movement of the lower shuttle pad.

In many instances, it will be preferred to perform the work operations with the components being in the spatial orientation shown in FIGS. 1–4. However, it should be understood that the invention is not limited to performance of the work operations in this orientation. Accordingly, words such as "upper," "lower," "horizontal" and "vertical" are used herein merely to aptly describe the specific embodiment and not to limit the invention.

FIG. 2 illustrates the same components shown in FIG. 1 with the punchholder 25 having been advanced to cause the punches 27 and 29 and the die cavities 17 and 19 to cooperate to perform work operations on the sheet material. By way of example, the punch 27 and the die cavity 17 cooperate to remove a slug 51 of the sheet material to thereby form an aperture 52 in the sheet material. The punch 29 and the die cavity 19 cooperate to blank out a washer-like element 53.

During the initial advancing phases of the punchholder 25 toward the die plate 11, the primary pressure pad 31 travels with the punchholder and ultimately engages the sheet material 23. Further downward movement of the punchholder 25 compresses the resilient connecting means (described hereinbelow with reference to FIG. 9) to thereby cause the primary pressure pad 31 to resiliently squeeze the sheet material therebelow against the upper surface 21 of the die plate 11. In this manner, the primary pressure pad 31 cooperates with the die plate 11 to assist in retaining the sheet material in position during the performance of the work operations. Upon further advance of the punchholder 25, the tooling cooperates as described hereinabove to form the aperture 52 and to blank out the washer-like element 53. If desired the tooling may perform an impact piercing operation as described in my said copending application.

As shown in FIG. 2, the shuttle pads 41 and 43 continue to tightly clamp the sheet material 23 in position. The clamping action of the shuttle pads 41 and 43 should continue at least until the primary pressure pad and the die plate 11 clamp the sheet material with sufficient force to prevent movement thereof and/or until the punches 27 and 29 interlocked with the sheet material by virtue of the apertures punched thereby. Preferably, the pads 41 and 43 remain in clamping engagement with the sheet material 23 during the performance of the work operations.

Once the primary pad **31** and the die plate **11** grip the sheet material **23** with sufficient force, the upper shuttle pad **41** is moved upwardly to thereby remove the pads **41** and **43** from clamping engagement with the sheet material as shown in FIG. **3**. Preferably upward movement of the upper shuttle pad **41** begins at or just prior to the completion of the work operations.

Next, with the shuttle pads **41** and **43** in the relative vertical orientation shown in FIG. **3**, the shuttle pads are moved horizontally to the right as viewed in FIGS. **1–4**. The shuttle pads **41** and **43** move an accurately predetermined distance, and then the upper shuttle pad **41** is moved downwardly to again clamp the sheet material between the pads **41** and **43** as shown in FIG. **4**. Such horizontal movement of the pad **43** is carried out with the lower face **49** thereof being in spaced relationship to the surface **15** of the support member **13**.

It is important that the sheet material **23** be maintained in position during the movement of the shuttle pads **41** and **43** from the position shown in FIG. **3** to the position shown in FIG. **4**. According to the embodiment illustrated, this is accomplished by the primary pressure pad **31** squeezing the sheet material against the upper surface **21** of the die plate **11** with spring pressure and also by the punches **27** and **29** which remain within the apertures formed thereby in the sheet material **23**.

When the shuttle pads **41** and **43** grip the sheet material **23** sufficiently to adequately retain same in position, the punchholder **25** begins its upward movement. Preferably this does not occur until the upper shuttle pad **41** has completed its downward clamping movement. When the punches **27** and **29** have cleared the apertures in the sheet material **23** formed thereby, the shuttle pads **41** and **43** move as a unit an accurately predetermined distance to the left to the position shown in FIG. **1** to thereby index the sheet material. In the embodiment illustrated, such indexing involves moving of the aperture **52** (FIG. **2**) formed in the preceding work operation by the punch **27** and the die cavity **17** into precise alignment with the axis of the end portion **33** of the punch **29**. In addition, a new section of the sheet material is brought into registry with the punch **27** and the die cavity **17**. The process can then be repeated as described above. If desired the end portion **33** could include an axial projection of bullet nose configuration for cooperating with the aperture **52** to finally align the punch **29** and the aperture. If this were done, the pads **41** and **43** would be operated to instantaneously release the sheet material to permit such alignment.

FIGS. **5–9** illustrate a press **61** which is particularly adapted for carrying out the sequence of operations shown in FIGS. **1–4**. However, the press **61** contains various features and advantages and is not limited to performing the operations described with reference to FIGS. **1–4**.

Portions of the press **61** shown in FIGS. **5–9** corresponding to components shown in FIGS. **1–4** are designed by corresponding reference numerals followed by the letter a. The press **61** includes a base **63**, four vertical support members **65**, **67** (FIG. **5**), **69** and **71** (FIG. **6**) and a horizontal support member **13***a*.

With reference to FIG. **6**, a portion of the vertical support member **71** is cut away to provide space for a bearing block **73**. The bearing block **73** supports roller bearings **75** and **77** in coaxial relationship. The bearings **75** and **77** have inner rings **79** and **81**, respectively, and a tubular drive shaft **83** is suitably connected to the inner rings **79** and **81** for rotation therewith. A shaft **85** having an enlarged end portion **87** is received within the tubular drive shaft **83** and is affixed thereto by a key **89** (FIG. **5**). The key **89** causes the shaft **85** to rotate with the drive shaft **83**, but permits relative axial movement therebetween, and thus the key **89** acts like a spline. A handwheel **91**, which also serves as a flywheel, is affixed to the shaft **85** by a screw **93** and a shoulder **95** on the shaft **85**.

With reference to FIG. **6**, an electric motor **97** drives the drive shaft **83** through a gear box **99**, a stub shaft **101**, and a splined coupling **103**. The splined coupling **103** includes a driving member **105** and a driven member **107** with the latter being suitably rigidly connected to the end of the drive shaft **85**. The driving member **105** is suitably mounted on the stub shaft **101** for rotation therewith and so as to permit relative axial movement therebetween and such connection may be formed by splines (not shown) if desired. The members **105** and **107** have cooperating teeth or splines **109** on the cooperating confronting end faces thereof to thereby drivingly connect the members **105** and **107**. A spring **111** acts between the driving member **105** and the gear box **99** to urge the teeth **109** of the members **105** and **107** into driving relationship. The enlarged end portion **87** of the shaft **85** is mounted within the coupling **103** with the end face thereof being engageable with the driving member **105**.

From the foregoing it will be apparent that the motor **97** drives the drive shaft **83** through the gear box **99**, the stub shaft **101**, the driving member **105** and the driven member **107**. Similarly, the shaft **85** rotates with the drive shaft **83** because the key **89** drivingly interconnects these two shafts. The handwheel **91** rotates with the shaft **85** and serves as a flywheel.

In addition, with the motor **97** turned off, the handwheel **91** may be used to facilitate start up of the press. To accomplish this, the handwheel **91** is urged axially inwardly to thereby force the end portion **87** of the shaft **85** against the driving member **105** to thereby urge the latter axially away from the driven member **107** against the biasing force of the spring **111**. The key **89** permits this relative axial movement between the shaft **85** and the drive shaft **83** to occur.

This separates the splines or teeth **109** and breaks the driving connection between the motor **97** and the drive shaft **83**. This allows rotation of the drive shaft **83** by the handwheel **91**.

A pair of cams **113** and **115** are mounted on the drive shaft **83** for rotation therewith by a pair of keys **117** and **119**, respectively. The cams **113** and **115** are retained on the drive shaft **83** by a nut **121** which is received on the end portion of the drive shaft. The cams **113** and **115** are held in axially spaced relationship by a spacer **123** which is mounted on the drive shaft **83**. The cam **113** has an internal platen cam track or cam surface **125** and an external shuttle pad cam surface **127**. The cam **115** has an internal stock transport cam surface **129**.

As shown in FIGS. **5** and **6**, the press **61** includes a platen **131** which carries a punchholder **25***a* (FIG. **5**)

and which is moved vertically by the cam surface **125** in response to rotation of the cam **113**. The platen **131** is supported by a pair of platen posts **133** and **135** (FIG. **6**), the lower ends of which are rigidly interconnected to a bracket **137**. The posts **133** and **135** are slidably supported for vertical movement by upper bearings **139** and lower bearings **141**. The bearings **139** and **141** are retained in bearing blocks **143** which are rigidly mounted on the support members **69** and **71**, respectively.

A cam follower **145** drivingly joins the bracket **137** and the platen cam surface **125**. The upper end of the cam follower **145** includes a stud **147** which is slidably received in a bore **149** of the bracket **137**. The opposite ends of the stud **147** are threaded and nuts **151** cooperate with the threaded portions of the stud **147** to rigidly mount the cam follower **145** on the bracket **137** with the relative axial position of the cam follower **145** and the bracket **137** being adjustable by the nuts **151**.

The cam follower **145** also includes a roller **153** or other suitable cam following element which is received in the platen cam surface **125**. Accordingly, rotation of the cam **113** causes cooperation between the cam surface **125** and the roller **153** to move the platen **131** and the punchholder **25***a* (FIG. **5**) vertically, such motion being transmitted through the cam follower **145**, the bracket **137**, and the platen posts **133** and **135**. Obviously, the cam surface **125** can be designed so that the desired vertical motion of the platen **131** and hence of the punchholder **25**a can be obtained.

As shown in FIG. **5**, the press **61** also includes an upper shuttle pad **41***a* and a lower shuttle pad **43***a*. The cam surfaces **127** and **129** control the movements of the pads **41***a* and **43***a*, such movements being of the type described hereinabove with reference to FIGS. **1–4**.

The upper pad **41***a* may be generally rectangular in plan and has an opening **45***a* therein with the primary pressure pad **31***a* lying within such opening. A plurality of vertical posts **155** (two being illustrated in FIG. **5**) are suitably rigidly mounted to the upper shuttle pad **41***a* and project downwardly through slots **157** and sleeve bearings **159**, the latter being mounted in and carried by a carriage **161**. The upper shuttle pad **41***a* is urged downwardly by springs **163** which bear against a plate **165** which in turn is rigidly affixed to the lower end of the posts **155**. Thus, the upper and lower ends of the post **155** are rigidly secured together by the upper shuttle pad **41***a* and the plate **165**, respectively. As shown in FIG. **5**, the springs act between the carriage **161** and the upper surface of the plate **165** to resiliently urge the upper shuttle pad **41***a* downwardly.

A shuttle pad arm **167** (FIG. **5**) is pivotally mounted by a pin **169** to a plate **171** with the latter being suitably rigidly affixed to the support member **65**. The shuttle pad arm **167** in the embodiment illustrated is in the form of a bell crank and the upper end thereof carries a shoe **173** which is pivotally affixed to the arm **167** as by a screw **175**. The upper surface of the shoe **173** bears against and is slidable along the lower surface of the plate **165** as shown in FIGS. **5** and **6**. A follower member in the form of a roller **177** is rotatably mounted on the lower end of the shuttle pad arm **167**. The roller **177** rolls along the shuttle pad cam surface **127** of the cam **113**. Thus, the cam surface **127** and the roller **177** cooperate to move the upper shuttle pad **41***a* vertically. Specifically, upward movement of the roller **177** pivots the arm **167** about the pin **169** to force the shoe **173** upwardly against the biasing action of the springs **163**. Such upward movement of the shoe **173** moves the posts **155** and hence the upper shuttle pad **41***a* upwardly. The sliding contact between the shoe **173** and the plate **165** accommodates the pivotal movement of the shuttle pad arm **167** and the springs **163** are operative to move the upper shuttle pad **41**a downwardly as permitted by the cam surface **127**.

The shuttle pads **41***a* and **43***a* are moved horizontally by the carriage **161**. Specifically, the carriage **161** is mounted for generally horizontal movement by rods **179** and **181** which project through the carriage **161** and which are suitably affixed thereto. The opposite ends of the rods **179** and **181** are supported for horizontal sliding movement by bearings **183** and **185** mounted on the vertical support members **65** and **67**, respectively. Bearings **187** support the rods **179** and **181** intermediate the ends thereof and are located in a block member **189** which may be rigidly mounted on the side members **69** and **71**. As the posts **155** project through the carriage **161**, horizontal movements of the carriage will result in horizontal movement of the posts **155** and the upper shuttle pad **41***a*.

The lower shuttle pad **43***a* is suitably rigidly affixed as by connectors **191** (FIG. **5**) to the carriage **161**. The connectors **191** project through the slots **157**. Accordingly, horizontal movement of the carriage **161** also results in corresponding horizontal movement of the shuttle pad **43***a*. The sliding connection between the shoe **173** and the plate **165** does not interfere with the horizontal movement of the carriage **161** and the shuttle pads **41***a* and **43***a*.

Horizontal movement is transmitted from the stock transport cam surface **129** to the carriage **161** by a stock transport arm **195** (FIGS. **5** and **7**). The stock transport arm **195** is connected by an adjustable pivot **197** to the plate **171** for pivotal movement about an axis intermediate the ends of the stock transport arm **195**. The upper end of the stock transport arm **195** has a slot **199** therein for receiving a bushing **201** which is generally rectangular in cross section. A pin **203** passes through the bushing and the end portions thereof are received within aligned openings in U-shaped members **205** and **207** (FIG. **7**) which receive the rods **179** and **181**, respectively. The U-shaped members **205** and **207** are rigidly affixed to the rods **179** and **181**, respectively, in any suitable manner such as by set screw **209**. Accordingly, movements of the upper end of the stock transport arm **195** are transmitted through the connector members **205** and **207** to the rods **179** and **181**.

The lower end of the stock transport arm **195** carries a cam follower element in the form of a roller **211**. The roller **211** is received within and cooperates with the cam surface **129** of the cam **115**.

Rotation of the cam **115** by the motor **97** causes the cam surface **129** to control the position of the roller **211**. This imparts pivotal movement to the stock transport arm **195** about the adjustable pivot **197**. Such pivotal movement causes the upper end of the stock transport arm **195** to move the bushing horizontally. Horizontal movement of the bushing **210** imparts a corresponding movement to the carriage **161** through the

pin **203**, the U-shaped members **205** and **207** and the rods **179** and **181**.

The adjustable pivot **197** can be operated to move the pivot point for the stock transport arm **195** without moving the arm itself. It will be appreciated that by moving the pivot axis for the stock transport arm **195** that the amount of horizontal movement imparted to the carriage **161** can be varied for any given cam surface **129**. Stated differently, by appropriately adjusting the adjustable pivot **197**, the press **61** can be adjusted to provide different distances of horizontal travel for the shuttle pads **41***a* and **43***a*. This means that the amount of stock fed in between each work operation can be adjusted and that the distance between stations can be adjusted.

Although the adjustable pivot **197** can be of different constructions, in the embodiment illustrated, the stock transport arm **195** and the plate **171** have elongated slots **213** and **215** (FIGS. **5**, **8** and **8***a*), respectively, with the slot **213** in the arm **195** being somewhat wider and longer than the slot **215**. The longitudinal sides of each of the slots **213** and **215** are linear and parallel and the two slots are in registry. The plate **171** has channels **217** and **219** on opposite sides thereof with the channels having straight parallel longitudinal sides and extending in the same direction as the slots **213** and **215**.

A supporting shaft **221** having a square head **223** and a threaded shank **225** projects through the slots **213** and **215**. The square head **223** is slidably received in the channel **219** so that the head can slide along the channel but cannot turn relative thereto. A tubular retainer **227** is slidably received on the shank **225** and has a flange **229** of square or rectangular configuration which is slidably received in the channel **217**. The flange **229** cooperates with the channel **217** to prevent relative rotation between the retainer **227** and the plate **171**. The square head **223** and the flange **229** are wider than the slot **215** so that they engage opposed portions of the plate **171**.

A nut **231** is screwed onto the threaded shank **225** and engages the retainer **227** to force the flange **229** thereof against the plate **217** and to draw the head **223** in the opposite direction against the opposite face of the plate. Accordingly, tightening of the nut **231** results in gripping or clamping of the plate **171** between the head **223** and the flange **229** with such clamping force being sufficient to rigidly mount the supporting shaft **221** in a preselected position along the plate **171**. The retainer **227** also supports the shank portion of the supporting shaft **221**.

A cylindrical bushing **233** is supported on the retainer **227** and an outer retainer **235** is mounted on the bushing **233**. The retainer **235** has a square section **237** (FIGS. **8** and **8***b*) which is received in the slot **213** and a flange **239**. The square section **237** is sized so as to be slidable in the slot **213** but to be nonrotatable relative thereto as shown in FIG. **8***b*. The square section **237** is slidable in the slot **213** and cooperates therewith to cause the arm **195** and the retainer **235** to pivot as a unit. Of course the section **237** need not be square, it only being necessary that it have a cross sectional shape which is cooperable with the slot **213** to lock the arm **195** and the retainer **235** for rotation while permitting relative sliding movement of the section **237** longitudinally in the slot **213**.

The outer end of the retainer **235** is circular and threaded and a nut **241** is screwed onto the outer end of the retainer **235**. The flange **239** and the nut **241** are wider than the slot **213** so that the arm **195** can be clamped between the flange **239** and the nut **241**. Accordingly, by tightening of the nut **241**, the retainer **235** is placed in tension to thereby cause the arm **195** to be clamped between the surface **243** of the nut **241** and the flange **249** with sufficient force to prevent slidingly movement of the retainer **235** in the slot **213** of the arm **195**.

When the arm **195** is pivoted, the nut **241** and the retainer **235** pivot therewith due to the driving connection afforded by the square section **237** and the slot **213**. Relative pivotal movement may occur between the retainer **235** and the bushing **233** and/or the busing **233** and the retainer **227**. The retainer **227** cannot rotate because the flange **229** thereof is slidably and nonrotatably received in the channel **217**. The supporting shaft **221** cannot rotate because the head **223** thereof is slidably and nonrotatably received in the channel **219**. With this construction, the pivot axis of the adjustable pivot **197** is the axis of the shank **225** and the bushing **233** and the retainer **235** cooperate to define bearing means for the arm **195**.

To adjust the location of the pivot axis, it is only necessary to loosen the nuts **231** and **241**. The entire adjustable pivot **197** can then be slid in the slots **213** and **215** to the new position desired whereupon the nuts **231** and **241** are tightened to permit pivotal movement of the arm **195** as described hereinabove. Specifically, the retainer **235** slides in the slot **213** and the shank **225** slides in both of the slots **213** and **215**. The head **223** and the flange **229** slide in the channels **219** and **217**, respectively. The arm **195** cannot move during movement of the adjustable pivot **197**. The only movement of the arm **195** permitted by the slot **213** and the adjustable pivot **197** is in the direction of the slot **213** and/or about the pivotal axis defined by the adjustable pivot. The upper end of the arm **195** can only move vertically as the carried **161** is preferably suitably locked in position prior to adjusting the pivot **197** and the lower end of the arm **195** can only move along the path defined by the cam surface **129** and such path is not vertical. Alternatively a spring (not shown) could act upwardly on the arm **195** to positively prevent the arm **195** from falling during adjustment of the pivot **197**.

If desired, the arm **195** may have indicia **245** (FIG. **5**) thereon serving as calibrations which, for a given cam surface **129**, indicate the amount of horizontal movement of the shuttle pads **41***a* and **43***a* obtainable for a given position of the adjustable pivot **197**. If the indicia **245** are used, the adjustable pivot should also include a pointer **247** (FIGS. **5** and **8**) movable therewith and having a marking thereon closely adjacent the indicia **245** to permit the operator to readily ascertain the amount of horizontal movement which will be obtained.

FIG. **9** shows the platen **131** having a bore **249** therein for receiving a compression spring **251** and a head **253** of a bolt **255**. The stripper bolt **255** projects through the punchholder **25***a* and is affixed at its lower end to a primary pressure pad **31***a*. When the platen **131** is moved downwardly, the pressure pad **31***a* contacts the upper surface of the sheet material **23***a* and

continued downward movement of the platen **131** results in compression of the spring **251** and the consequent application of spring pressure to the sheet material thereby clamping the latter firmly against the die plate **11a**. Similarly, during the initial portion of the upward stroke of the platen **131**, the pressure pad **31***a* remains in contact with the sheet material **23***a* while the spring **251** expands. Ultimately the head **253** strikes the upper surface of the punchholder **25***a* whereby further upward movement of the platen **131** elevates the pressure pad **31a** from the sheet material **23***a*.

In operation of the press **61**, the cams **113** and **115** are rotated by the motor **97** during normal operation of the press and by the hand wheel **91** during set up, it being possible to disengage the motor **97** by moving the handwheel **91** axially to the right as viewed in FIG. **6**. When the motor **97** drives the cams **113** and **115**, the handwheel **91** rotates with the drive shaft **83** to serve as a flywheel.

Assuming that the platen **131** is initially raised to its uppermost position and that the shuttle pads **41***a* and **43***a* tightly grip the sheet material **23***a*, rotation of the cams **113** and **115** drives the platen **131** downwardly through the cam follower **145**, the bracket **137** and the platen posts **133** and **135**. During this time, the cam surfaces **127** and **129** dwell so that the shuttle pads **41***a* and **43***a* continue to tightly grip the sheet material.

At or near the completion of the downward stroke of the platen **131**, the primary pressure pad **31***a* (FIG. **9**) clamps the sheet material **23***a* against the die plate **11a** described in connection with FIG. **9** hereinabove. With the sheet material **23***a* securely clamped, the cam surface **127** pivots the shuttle pad arm **167** upwardly to impart upward movement to the upper shuttle pad **41***a* through the shoe **173**, the plate **165** and the posts **155**. This results in the unclamping of the sheet material **23***a* by the shuttle pads **41***a* and **43***a*.

Next, with the sheet material **23***a* being tightly clamped in position between the pressure pad **31***a* and the die plate **11***a* (FIG. **9**), the cam surface **129** imparts pivotal movement to the stock transport arm **195** to thereby pivot the latter about the pivot axis established by the adjustable pivot **197**. This imparts horizontal movement to the carriage **161** through the bushing **201**, the pin **203**, the U-shaped members **205** and **207** and the rods **179** and **181**. Horizontal movement of the carriage **161** moves the lower shuttle pad **43***a* by virtue of the connectors **191** which connect the carriage and the lower shuttle pad for movement. Because the posts **155** which are joined to the upper shuttle pad **41***a* project vertically through the carriage **161**, horizontal movement of the carriage also imparts horizontal movement to the upper shuttle pad **41***a*. The sliding contact between the shoe **173** and the plate **165** permits the carriage to move horizontally relative to the shuttle pad arm **167**.

The cams **113** and **115** continue to operate the platen **131** and the shuttle pads **41***a* and **43***a* in the manner described hereinabove with reference to FIGS. **1–4**, it being understood that the cam surfaces could be selected to provide a different mode of operation, if desired.

FIGS. **6***a* and **6***b* show a modified construction of the shuttle pad arm which permits adjustment of the latter so that the press can readily accommodate different thicknesses of sheet material. Parts of FIGS. **6***a* and **6***b* corresponding to parts of FIGS. **5** and **6** are designated by corresponding primed reference numerals, and except as specifically shown or described, the construction of FIGS. **6***a* and **6***b* is identical to that shown in FIGS. **5** and **6**.

The shuttle pad arm **167'** includes a body **401** carrying the roller **177'** and pivotally mounted on the plate **171'** by a suitable pin or shaft **169'**. The body **401** includes spaced web sections **403** and **405** defining a slot **407** therebetween. The arm **167'** also includes a member **409** which is pivotally mounted on the pin **169'** by a bushing **411** for movement in the slot **407**. The member **409** has an arcuate slot **413** therein and a screw **415** or other suitable element projects through the slot **413** to releasably clamp the web sections **403** and **405** against the member **409**. The sloe **173'** is pivotally carried by the outer end of the member **409** so that by adjusting the position of the member **409** using the screw **415**, the position of the shoe **173'** is correspondingly adjusted. This in turn changes the vertical position of the shuttle pad **41***a* relative to the pad **43***a*.

FIGS. **10–12** illustrate somewhat diagrammatically the performance of two work operations on sheet material in a one-hit operation. FIG. **10** illustrates a punch **271** and a die **273** for performing work operations on sheet material **275**. The punch **271** includes coaxial cylindrical sections **277** and **279** with the section **277** projecting axially beyond the section **279**. The punch **271** projects through a primary pad **337** which performs the usual sheet material clamping function. As with the other embodiments of the invention, this embodiment of the invention is not limited to use with the particular form of punch illustrated.

The die **273** includes a die plate **281**, and outer die **283**, and an inner die **285**. The outer die **283** has an opening or die cavity **287** therein having a configuration conforming to the configuration of the periphery of the section **279** of the punch **271**. Accordingly, in the embodiment illustrated, the opening **287** is generally cylindrical. The outer die **283** is suitably retained in the die plate **281** and the die plate is in turn suitably fixedly mounted on the press.

The inner die **285** has a cavity **289** sized to cooperate with the section **277** to permit the piercing of an aperture **291** in the sheet material **279**. The upper end of the inner die **285** is slidably received within the opening **287**.

The inner die **285** is suitably mounted on a bolster or plate-like member **293** which is urged downwardly by a plurality of springs **295** which bear against a lower bolster **297**. The lower bolster **297** is fixedly mounted relative to the die plate **281**, and the bolster **293** and the inner die **285** are mounted for generally vertical movement relative to the bolster **297** and the die plate **281**. The springs **295** are of sufficient force to maintain the inner die **285** in the position shown in FIG. **10** during the piercing of the sheet material **285** to form the aperture **291**. In this position, the upper face of the inner die **285** is substantially coplanar with the upper face of the outer die **283**. The upward travel of the bolster **293** can be limited to any suitable manner.

The formation of the aperture **291** creates a slug **299** which escapes through the die cavity **289**, an opening **301** in the bolster **293** and a tubular slug guide **303**.

In FIG. 11, the section 279 cooperates with the die cavity 287 to blank out a washer-like element 305 and to form an aperture 306 in the sheet material 275. To prevent coining of the sheet material which ultimately forms the washer-like element 305 between the section 279 and the inner die 285, the inner die is retracted prior to the application of sufficient squeezing force to the sheet material to achieve any adverse effect. According to the present invention, this is accomplished by a drive member 307 which is engageable to the bolster 293 to move the latter downwardly. Preferably, the drive member 307 is driven by a suitable driving connection 309 from the same means 310 which drives the punch 271. Accordingly, the drive member 307 may be driven by the toolholder for the punch 271 or by the platen. In any event, the drive member 307 descends with the punch 271 and drivingly engages the bolster 273 at some time after the piercing operation shown in FIG. 10 and before the sheet material 275 is substantially squeezed between the section 279 and the inner die 285.

As shown in FIG. 11, the drive member 307 descends with the punch 271 to force the bolster 293 and the inner die 285 downwardly against the biasing force of the springs 295. In this manner, the inner die 285 is mechanically retracted by means other than the punch 271 to thereby prevent coining of the washer-like element 305.

Upon completion of the downward stroke of the punch 271, the punch is moved upwardly and the drive member 307 moves therewith. This allows the springs 295 to expand to return the components to the position shown in FIG. 10. However, in returning the inner die 285 to the initial position (FIG. 10) the inner die 285 forces the washer-like element 305 upwardly into the aperture 306 (FIG. 12) from which it is blanked out. As the inner die 285 is not retracted beneath the die cavity 287, the washer-like element 305 is not allowed to escape during the blanking operation. The washer-like element 305 is then carried with the sheet material 273 to a subsequent work station in which another tool (not shown in FIGS. 10–12) removes it from the sheet material 273.

A preferred construction for carrying out the concepts described with reference to FIGS. 10–12 is shown in FIGS. 13 and 14. Parts shown in FIGS. 13 and 14 which are identical to parts shown in FIGS. 10–12 are designated by corresponding reference numerals. As shown in FIGS. 13 and 14, a platen 311 is connected to a toolholder or punchholder 313 which mounts a plurality of the punches 271 and a plurality of knockout punches 315. the platen 311 may be of the type shown in FIGS. 5 and 6 and may be driven by the press construction shown in FIGS. 5 and 6, if desired. The toolholder 313 is mounted on the platen 311 in any suitable manner such as by a plurality of screws 317. The punchholder 313 may be of any suitable construction.

The sheet material 275 may be advanced through the work stations by shuttle pads 318 and 318*a* in the same manner described hereinabove with reference to FIGS. 1–4. The sheet material 275 rests on the upper face of the die plate 281 and the upper faces of the several outer and inner dies as shown in FIGS. 10 and 11. The die plate 281 also has a plurality of knockout dies 319 mounted therein for cooperating with the knockout punches 315 to remove the washer-like elements 305 (FIG. 12) from the apertures 306.

As shown in FIG. 13, the bolster 293 is slidably retained within a recess in the die plate 281 and the die plate 281 rests on the lower bolster 297, which in turn is mounted on a rigid, fixed support member 321.

A preferred form of driving the bolster 293 can best be understood from reference to FIG. 14. The platen 311 is supported by a pair of vertical platen posts 323 and 325 which are suitably rigidly affixed to the platen and which project downwardly therefrom through openings in the support member 321. The driving connection between the platen 311 and the bolster 293 is formed by a pair of drive members or bump rods 327 and a pair of headed members 328 affixed to the bolster 293. The bolster 293 is urged upwardly by the springs 295 which are retained within appropriate upwardly opening recesses in the lower bolster 297. The maximum upward position of the bolster 293 is defined by the engagement of the upper surfaces of the headed members 328 with surfaces 329 of the die plate 281. As the die plate 281 is suitably retained in a fixed position, the maximum upward position of the bolster 293 and hence of the inner dies 285 is correspondingly fixed. Preferably, in such maximum upward position the upper faces of the inner dies 285 are flush with the upper faces of the outer dies 283.

In the position shown in FIG. 14, the platen 311 is advanced downwardly to move the bolster 293 downwardly against the biasing force of the springs 295. With the bolster 293 in its uppermost position, the drive members 327 are retracted slightly within the die plate 281 and their end faces 331 are spaced from the upper surface of the members 328 to thereby allow some downward travel of the platen 331 with the punches 271 before the drive members 327 begin to urge the bolster 293 and hence the inner dies 285 downwardly. This initial spacing should be sufficient to allow the sections 277 of the punches 271 to perform the first work operation as described hereinabove with reference to FIG. 10.

Each of the drive members 327 has an upper end in the form of a screw 333 which is received in a correspondingly threaded bore 335. Accordingly, this permits vertical adjustment of the drive members 327 relative to the platen 311. This permits adjustment of the amount of travel of the platen 311 which can occur before the drive members 327 become operative to begin withdrawing the inner dies 285.

The assembly shown in FIGS. 13 and 14 also includes a primary pad 337 which performs the usual function of clamping the sheet material 275 against the upper surface of the die plate 285 during at least a portion of the advancing movement of the platen 311. The primary pad 337 is connected to the platen 311 by a plurality (two being illustrated in FIG. 14) of compound connector members 339. Each of the connector members 339 includes a bolt 341 affixed to the primary pad 337 at its lower end and having a head slidably received within a bore 343 formed in the platen 311 and the toolholder 313. The bolt 341 is urged downwardly by a spring 345 which is received in the bore 343. Each of the connector members 339 also includes a screw 347 connected to the bolt 341 and having an upper threaded portion 349. An adjusting nut 351 and a lock

nut 353 are received on the screw 347. By turning of the adjusting nut 351 and the lock nut 353, the position of the connector member 339 relative to the platen 311 can be adjusted. This causes a corresponding movement on the part of the primary pad 337 to thereby permit adjustment of pad elevation in accordance with the lengths of the punches 271.

In the operation of the embodiment of FIGS. 10–14, the drive members 327 are initially in an upward position in which the end faces 331 thereof are spaced upwardly from the headed members 328. The bolster 293 is retained in an upper position by the engagement of the upper faces of the headed members 328 with the surfaces 329 (FIG. 14). In this position, the upper faces of the dies 283 and 285 are substantially flush.

The platen 311 is then moved downwardly to perform a work operation such as the work operation shown in FIG. 10. At or near the completion of this work operation, the end faces 331 engage the upper faces of the headed members 328 whereupon further downward movement of the platen depresses the bolster 293 and the dies 285 and causes the performance of a second work operation such as the blanking operation shown in FIG. 11. During the subsequent upward movement of the platen 311, the springs 295 return the bolster 293 to the upward position thereof and the blanked out part 305 is returned as shown in FIG. 12.

FIG. 15 shows another mechanism for adjusting the position of the primary pad which mechanism may be incorporated into the construction of FIGS. 13 and 14 in lieu of the primary pad adjustment mechanism shown.

In FIG. 15 a primary pad 371 is connected to a platen 372 by a bolt 373 which passes through a bore 375 in the primary pad and through a bore in the platen. The end portions of the bolt 373 are threaded and nuts 377 and 379 are mounted thereon. A spring 381 urges the primary pad 371 downwardly away from the platen 372. Thus, by turning the nut 377 the vertical position of the primary pad 371 relative to the platen 372 can be adjusted.

Moreover, the bore 375 loosely receives the bolts 373 to thereby permit a small amount of relative horizontal movement between the primary pad 371 and the bolt 373. This permits the primary pad to move horizontally to accommodate the punches which extend therethrough as shown in FIG. 14.

Many obvious changes can be made to the illustrated embodiments of the invention. For example, the press can be arranged to advance the sheet material through the work stations in either direction. The cams shown in FIGS. 5 and 6 can be either internal or external and each of the shuttle pads can be formed as two separate members in lieu of a single apertured member as shown in FIGS. 1–4.

Although exemplary embodiments of the invention have been shown and described, many changes, modifications and substitutions may be made by one having ordinary skill in the art without necessarily departing from the spirit and scope of this invention.

I claim:

1. A press for operating tooling means at a work station to perform work operations on sheet material comprising:

means for operating the tooling means to cause said tooling means to perform said work operation on the sheet material at said station;

releasable means for retaining the sheet material in position at least during the operation of said tooling means;

upper and lower shuttle pads on opposite sides of the sheet material adjacent the tooling means;

means defining a surface immediately beneath said lower shuttle pad;

means for moving said shuttle pads toward each other and into clamping relationship with the sheet material;

means for moving said shuttle pads relative to said surface from an initial position to a second position when the shuttle pads are in clamping relationship with the sheet material to thereby move the section of sheet material initially at said station to a predetermined location and to move a second section of sheet material to said station;

means for holding said shuttle pads out of substantial contact with said surface and out of substantial sliding contact with the remainder of the press at least during the movement of said shuttle pads from the initial position to the second position whereby frictional losses due to such movement is minimized;

means for moving said shuttle pads out of clamping relationship with the sheet material; and

means for returning the shuttle pads from said second position to said initial position.

2. A press as defined in claim 1 wherein each of said shuttle pads includes first and second portions located on opposite sides of the tooling means and offset from each other generally in the direction of the movement of the sheet material from the initial position to the second position.

3. A press as defined in claim 1 wherein said means for holding includes a carriage mounted for generally horizontal movement beneath said pads, said lower pad being mounted on and supported by said carriage.

4. A press for performing a work operation on sheet material and for advancing the sheet material through the press comprising:

a supporting structure;

a platen;

means for mounting the platen on the supporting structure for movement toward and away from the sheet material to allow a work operation to be performed on the sheet material;

upper and lower pads, the sheet material being adapted to be positioned between said pads;

means for moving said pads generally toward and away from each other to clamp and unclamp the sheet material and in a shuttle motion to index the sheet material through the press; and

said moving means including a power transmitting member, means for mounting said member on said supporting structure for pivotal movement relative thereto about a pivot axis, means for pivoting said member about said pivot axis to drive at least said one pad, and means for drivingly connecting said member and at least one of said pads for movement of at least said one pad, means for adjusting the location of said pivot axis while allowing said

member to remain in the same position relative to the supporting structure whereby a characteristic of the motion of at least said one pad can be varied.

5. A press as defined in claim 4 wherein said member includes an arm and said pivot axis is intermediate the ends thereof, said means for pivoting includes a cam drivingly associated with said arm.

6. A press as defined in claim 5 wherein said moving means includes a carriage beneath said pads mounted for generally horizontal movement, means for drivingly connecting said carriage and said pads, a shaft affixed to said carriage and drivingly connected to said arm.

7. A press as defined in claim 6 wherein said lower pad is mounted on and supported by said carriage whereby said carriage holds said lower pad substantially out of sliding contact with other portions of the press, each of said pads including first and second portions for clamping regions of the sheet material on opposite sides of the location where the work operation is performed.

8. A press for performing a work operation on sheet material and for advancing the sheet material through the press comprising:

a supporting structure;

a platen;

means for mounting the platen on the supporting structure for movement toward and away from the sheet material to allow a work operation to be performed on the sheet material;

upper and lower secondary pads, the sheet material being adapted to be positioned between said pads;

a carriage beneath said secondary pads;

means for mounting said carriage on said supporting structure for movement along a first path;

means for drivingly connecting said carriage and said secondary pads for movement of said secondary pads with said carriage along said first path;

means for mounting one of said secondary pads for movement relative to the other of said secondary pads along a second path to thereby permit said pads to clamp and unclamp the sheet material;

means for moving said pads relative to each other along said second path in a predetermined timed relationship with the movement of said carriage along said first path whereby the secondary pads can be utilized to index the sheet material through the press;

said supporting structure including a supporting member having a slot extending therethrough;

an arm having a slot extending therethrough, said arm being drivingly connected to said carriage;

a supporting shaft extending through both of said slots, said supporting member and said arm being relatively positionable about said shaft so that said slots are generally in registry;

first means for releasably mounting said shaft on said supporting member;

bearing means mounted on said shaft and at least partially in said slot of said arm for mounting said arm on said shaft for pivotal movement relative thereto about a pivotal axis whereby pivotal movement of said arm drives said carriage along said first path;

second means for releasably drivingly connecting at least a portion of said bearing means to said arm for pivotal movement therewith; and

means for retaining said arm on said bearing means whereby upon releasing of said first and second means said bearing means and said shaft can be moved in said slots relative to said arm and said supporting member to thereby move said pivot axis relative to both of said arm and said supporting member.

9. A press as defined in claim 8 wherein said drive means includes a drive member drivingly connected to one of said platen.

10. A press as defined in claim 8 wherein said drive means includes a drive member mounted on said platen for movement therewith and means for adjusting the position of said drive member relative to said platen to thereby adjust the point at which the drive member begins to move the inner die away from the sheet material.

11. A press as defined in claim 8 including a plate-like member, means for mounting said inner die on said plate-like member, means for mounting said plate-like member for movement toward and away from the sheet material, said resilient means including at least one spring for urging the plate-like member toward the sheet material, and said drive means includes a drive member driven by said platen into driving engagement with said plate-like member.

12. A press as defined in claim 3 wherein said surface is intermediate said carriage and said lower shuttle pad.

13. A press for performing a work operation on sheet material and for advancing the sheet material through the press comprising:

a supporting structure;

a platen;

means for mounting the platen on the supporting structure for movement toward and away from the sheet material to allow a work operation to be performed on the sheet material;

upper and lower shuttle members, the sheet material being adapted to be positioned between said shuttle members;

a carriage beneath said shuttle members;

means for mounting said carriage on said supporting structure for movement along a first path;

means for moving said carriage along said first path, said last mentioned means including a first rotatable cam, an arm pivotally mounted on the supporting structure and engageable with and pivotable by said first cam, and means for drivingly connecting the arm and the carriage;

means for drivingly connecting said carriage and at least one of said shuttle members for movement of said one shuttle member with said carriage along said first path;

means for mounting the other of said shuttle members for movement with said carriage along the first path and relative to the carriage along a second path to thereby permit said shuttle members to clamp and unclamp the sheet material, said last mentioned mounting means including a passage extending through said carriage and a mounting member connected to said other pad and projecting through said passage;

a second arm pivoted to said supporting structure for driving said mounting member axially in said passage;

a second cam engageable with the second arm for pivoting said second arm; and

means including relatively sliding surfaces for drivingly connecting said second arm and said mounting member to allow said second arm to drive said mounting member axially in said passage and to allow said mounting member to move with said carriage along said first path relative to said second arm whereby said shuttle members can be utilized to index the sheet material through the press.

14. A press as defined in claim **13** including a third cam for driving the platen, a shaft mounted for rotation on said supporting structure, said first, second and third cams being mounted on said shaft for rotation therewith.

15. A press as defined in claim **13** wherein said means for mounting said carriage includes at least one rod mounted for reciprocating movement on said supporting structure and affixed to said carriage, said first arm being drivingly connected to said rod.

16. A press as defined in claim **13** wherein said first cam includes first and second cam surfaces for pivoting said first arm in first and second directions, respectively, about the pivotal axis of said first arm.

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