PRESS WITH MULTIPLE SHUTTLE FEED

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ABSTRACT
A press including a supporting structure, a platen mounted on the supporting structure for movement relative thereto, and a cam drive for moving the platen toward and away from the stock to perform work operations on the stock. The cam drive includes a first cam for driving the platen up and a second cam for driving the platen down. Stock is fed to the press by a feed which includes two shuttles. The shuttles operate sequentially so that one shuttle moves through a feeding stroke while the other shuttle moves through a return stroke.

32 Claims, 20 Drawing Figures
PRESS WITH MULTIPLE SHUTTLE FEED

BACKGROUND OF THE INVENTION

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

My copending application Ser. No. 46,009, filed June 15, 1970, now U.S. Pat. No. 3,712,163, discloses a press and a feed or feeding device which possess numerous advantages. This press is cam operated and employs a single shuttle to feed the stock through the press.

The single shuttle includes upper and lower shuttle members which are movable into and out of clamping relationship with the sheet material and which can be reciprocated. The shuttle members are first moved into clamping relationship with the stock and then moved in one direction to feed or index the stock. At the completion of the feeding stroke, the stock is retained by other means, and the shuttle members move out of clamping engagement with the stock. The shuttle then moves through a return stroke, following which the shuttle members are again moved into clamping relationship with the stock, and the cycle is repeated.

SUMMARY OF THE INVENTION

The present invention provides a press and a feed which are improvements over the press and feed described in my copending application. The press of the present invention is also adapted to higher tonnages.

With the present invention, the speed of the feed is increased by employing multiple shuttles. With only one shuttle, no stock feeding is obtained during the return stroke of that shuttle. However, with properly sequenced multiple shuttles one shuttle feeds while the other shuttle is being returned.

Another advantage of multiple shuttles is that they can be operated so that at least one shuttle is always gripping the stock to prevent unintended stock movement. With only one shuttle, this shuttle does not grip the stock during the return stroke, and therefore an additional stock holding device must be used during the return stroke of the shuttle.

To minimize vibration and to facilitate stopping of the press and feed, the drive for the press and feed as well as all of the moving parts should be moved as slowly as possible. On the other hand, it is obviously advantageous to carry out the work operations with the press as rapidly as possible. One advantage of the present invention is that the speed of the moving parts of the feed is low relative to the number of stock indexing movements. The multiple shuttles can be operated without increasing the speed of the drive or the moving parts of the feed over the speed required for a single shuttle. Nor is it necessary to step up the motion obtained from the drive to operate the shuttles.

For example, for dual shuttles, this can be established by moving a member back and forth through a number of cycles. The back and forth motion can be reciprocation or oscillation. On one stroke, this member simultaneously drives a first shuttle through a feed stroke and a second shuttle through a return stroke. On the other stroke of the member, the first shuttle is driven through the return stroke and the second shuttle is driven through the feed stroke. Thus, one cycle of reciprocation or oscillation results in two separate feed strokes. If only a single shuttle were employed, then only one feed stroke would be obtained per cycle of movement of the member. Thus, the present invention increases the speed of the feed by at least a factor of two without increasing the speed of the feed drive mechanism.

This concept can be advantageously implemented by providing first and second reciprocatory members including first and second rack sections, respectively. Gear means cooperates with the rack sections to drive the reciprocating members in opposite directions. The first and second shuttles are driven by the first and second reciprocatory members, respectively. In a preferred construction, the first and second reciprocatory members are upper and lower reciprocatory members, respectively.

The gear means is driven first in one direction and then in the other by a driving rack. The driving rack is reciprocated by a pivotable arm which is oscillated by a cam. One function of the arm is that the pivot axis thereof can be adjusted to thereby adjust the length of stroke of the shuttle.

Each of the shuttles must be movable into and out of clamping relationship with the stock. Accordingly, each of the shuttles includes first and second shuttle members with at least one of the shuttle members being mounted for movement toward and away from the other shuttle members. Both of the shuttle members of each shuttle can be reciprocated by the associated reciprocatory member. A cam and a lifter are provided for moving the shuttle members into and out to clamping engagement with the stock. The lifter projects through at least one of the reciprocatory members.

Although the feed of this invention has many uses, it is particularly adapted for use with the press of this invention. Generally the press includes a supporting structure, a platen mounted on the supporting structure for movement relative thereto, and drive means for moving the platen through a plurality of cycles to perform work operations on the stock.

The platen is driven by rotatable cam means. To minimize vibration and to facilitate stopping, it is desirable to obtain multiple strokes of the platen such as two strokes of the platen for each revolution of the cam means. To minimize vibration and clutter, it is desirable that the cam follower for the cam means be in continuous contact with the cam. To maintain the construction of the press as simple and inexpensive as possible, the followers are preferably fixed relative to the structure which it moves. It is not possible to meet all three of these parameters with a single cam. Accordingly, the present invention provides first and second cams mounted on the same cam shaft and rotatable together for raising and lowering the platen, respectively. This enables the cam followers to be in constant contact with their respective cams throughout the full angular movement of the cams, and the cam followers need not be movable relative to the structure which they move. In addition, two strokes of the platen per revolution of the cam shaft are obtained.

When the press and feed are used together, the platen is driven through n cycles per minute, the press and feed drives are driven through n/2 cycles per min-
ute and indexing movements of the stock per minute is obtained.

In a preferred construction, the cam followers drive a cam housing which in turn is coupled to a plurality of draw rods connected to the platen. The draw rods are mounted in axially elongated bearings in the supporting structure of the press such as ball cages. This provides very low friction and extreme accuracy to the extent that the usual die set is eliminated.

To permit adjusting the range of the platen movement, the cam housing is coupled to the draw rods through an adjustable coupling which allows the draw rod platen to be raised and lowered relative to the cam. Prior art adjustments of this type have been adjustable only with the press shut down. If the adjustment is made with the press shut down, the dynamic loads created when the press is running may cause the range of platen movement to be something other than what was anticipated. Thus, with prior art constructions, the coupling is reset by trial and error until an appropriate setting is obtained.

With the present invention, the adjustable coupling can be adjusted from outside of the press while the press is running. This eliminates the need for trial and error setup. This can advantageously be accomplished by employing a nut coupled to the draw rods and a screw on the cam housing with the periphery of the nut forming a gear. A second gear drives the nut and this second gear is in turn driven by a motor. A digital read-out is provided to inform the operator what setting has been selected. Another advantage of this construction is that the motor can drive the gears at high speeds to rapidly elevate the platen so that the punches carried thereby can be inspected or replaced.

To facilitate the stopping of the press and to reduce the work which the main cams must do in driving the platen, all of the vertically movable parts of the press are supported, at least in part, by an air cylinder. The concept is to support all or a substantial portion of the free weight of the movable parts on the air cushion in the air cylinder. The compressed air in the air cylinder helps the mass of the moving parts to stop on the down stroke.

It is sometimes desirable to perform work operations in a press that requires the horizontal movement of a tool. To accomplish this, it is necessary to add an additional station and to provide for some camming arrangement to convert the vertical movement of the platen into a horizontal movement of the tool. To solve these problems and simplify construction, the present invention provides forming cams on the press adjacent the platen. The forming cams are driven by a power take-off from the press drive and are arranged to drive a forming tool horizontally. This enables the horizontal work operation to be carried out at any time in the cycle and not just on the downstroke of the platen. It also eliminates a work station in that the horizontal forming operation can occur on the upstroke of the platen. This also saves die stations and therefore the cost of the dies is reduced.

The invention can 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 longitudinal sectional view through a press constructed in accordance with the teachings of this invention.
FIG. 2 is a sectional view taken generally along line 2--2 of FIG. 1.
FIG. 3 is a sectional view taken generally along line 3--3 of FIG. 1.
FIG. 4 is a fragmentary sectional view taken generally along line 4--4 of FIG. 1 and showing the press and the feeding device.
FIG. 5 is a sectional view taken generally along line 5--5 of FIG. 1.
FIG. 6 is a fragmentary sectional view taken generally along line 6--6 of FIG. 5 and illustrating one manner in which the forming cams may be used.
FIGS. 7--12 are schematic views illustrating the cooperation of the stock feeding device and the press.
FIG. 13 is a sectional view through a preferred form of feeding device taken generally along line 13--13 of FIG. 14.
FIG. 13a is an enlarged view of a portion of FIG. 13.
FIG. 14 is a sectional view taken generally along line 14--14 of FIG. 13a.
FIG. 14a is a sectional view taken generally along line 14a--14a of FIG. 14 and showing the adjustable stop.
FIG. 15 is an enlarged, fragmentary sectional view taken generally along line 15--15 of FIG. 14 and rotated 90° clockwise.
FIG. 16 is an enlarged fragmentary sectional view taken generally along line 16--16 of FIG. 13 and rotated 90° clockwise.
FIG. 17 is an enlarged fragmentary sectional view taken generally along line 17--17 of FIG. 14 and showing one preferred way of drivingly interrelating one end of the bell crank or arm to the cam for the feeding device.
FIG. 18 is a perspective view in somewhat schematic form of a portion of the stock feeding device.

DESCRIPTION OF THE PREFERRED EMBODIMENT
The Basic Press
FIGS. 1--3 show a press 21 having a supporting structure which includes a base 23 and end walls 25 and 27 (FIGS. 2 and 3) mounted on the base. The base 23 defines an oil reservoir 28 for a recirculating lubrication system for the press 21. A stock feeding device 29 constructed in accordance with the teachings of this invention is mounted in any suitable manner on the end wall 27. The press 21 is driven by a motor 31 (FIG. 2) suitably mounted on the end wall 25. This motor 31 drives an air clutch and brake 33 (FIG. 1) by a belt drive 35.

When the clutch 33 is engaged, it drives a camshaft 37 through a stub shaft 39 and a coupling 41. The camshaft 37 and the stub shaft 39 are mounted in suitable bearings such as roller bearings 43 which in turn are mounted on a pillow block 45 affixed to the base 23. In addition, the camshaft 37 is supported by bearings 47 which are retained in a pillow block 48. The bearings 43 and 47 are axially preloaded by a pair of nuts 49.
A lifting cam 51 and a pair of lowering cams 53 are mounted on the camshaft 37 for rotation therewith. The cams 51 and 53 are identical with the lifting cam 51 being oriented 90° out of phase with the lowering cams 53. The lowering cams 53 have identical orientations on the camshaft 37.

Cam followers 55 and 57 are rotatably mounted in a cam housing 59 and engage the cams 51 and 53, respectively. The cam followers 55 and 57 are rotatably mounted by shoes 61 and 63, respectively. A spacer 65 is provided intermediate the cam housing and the shoe 63 and a wedge block 67 is mounted intermediate the cam housing and the shoe 61. The wedge block 67 and the shoe 61 have cooperating wedge surfaces, and the wedge block is urged axially outwardly by a spring 69. The wedge block 67 is held in position by a threaded stud 71 in a cover plate 73. If the cam follower 55 wears, the stud 71 is screwed further into the cover plate 73 to drive the wedge block 67 to the left as viewed in FIG. 1 thereby providing a radial inward load against the follower 55. The stud 71 is locked in position by a locking screw 75 access to which can be had through a passage 77 in the pillow block 48.

The cam housing 59 includes a cover plate 79 mounted by a screw 81 which can be removed to provide access through an opening 83 in the pillow block 48 to the spacer 65, the shoe 63, and the cam follower 57. By removing the cover plate 79, the cam follower 57 can be replaced through the opening 83.

An adjustable coupling attaches the cam housing 59 to a draw rod platen 85. The adjustable coupling in the embodiment illustrated includes an adjusting screw 87 fixedly mounted on the cam housing 59, an adjusting nut 89 rotatably mounted on the draw rod plate 85, and cooperating with the screw, and a retainer 91 for retaining the nut on the draw rod platen 85. The screw 87 passes through an oversize bore in the draw rod platen 85. The outer periphery of the nut 89 has teeth defining a gear 93 which is adapted to cooperate with a worm 95 which is rotatably mounted on the draw rod platen 85. The worm 95 is driven by a stepping motor 97. Rotation of the worm 95 rotates the nut 89 to move the draw rod platen 85 axially of the screw 87 and relative to the cam housing 59. A digital readout 98 provides an indication to the operator of the relative positions of the cam housing 59 and the draw rod platen 85.

An upper platen 99 is attached to the draw rod platen 85 by four draw rods 101 and two pair of tie bars 103. Each pair of the tie bars 103 is suitably affixed to the draw rod platen 85 and to an adjacent pair of the draw rods 101. In the embodiment illustrated, each of the tie bar pairs 103 includes two individual tie bars (FIG. 1) appropriately secured together and extending around approximately one-half of the periphery of the draw rods 101 which are affixed thereto.

As shown in FIG. 2, each of the draw rods 101 is mounted for low friction, axial, reciprocating movement by a lower ball cage 105 and an upper ball cage 107. The ball cages 105 are mounted in a bearing block 109 affixed to the base 23. The ball cages 107 are mounted in the end wall 25 and the bed 111 of the press. The ball cages 105 and 107 provide a low friction mount for the draw rods 101 and very accurately mount the draw rods for reciprocation along a vertical path.

Each of the draw rods 101 also extends through a sleeve bearing 113 carried by the cam housing 59. In actual operation of the press 21, the draw rods 101 reciprocate with the cam housing 59 and so there is no relative motion between the sleeve bearing 113 and the draw rods 101. However, when the nut 89 is rotated to adjust the position of the cam housing 59 relative to the draw rod platen 85, the sleeve bearings 113 allow the cam housing to move relative to the draw rods 101.

In addition to being affixed to the draw rod platen 85, each of the draw rods 101 is affixed adjacent its upper end by a nut 115 (FIGS. 1–3 and 5) to the upper platen 99. The platen 99 is adapted to carry a plurality of tools for performing work operations on sheet material.

To minimize the amount of work that the cams 51 and 53 must do and to facilitate stopping of the press 21, an air cylinder 119 is mounted on the base 23. The air cylinder 119 includes a housing 121, a piston 123, and a rod 125 connected to the piston and projecting upwardly therefrom through the base. A button 127 is mounted on the cam housing 59 and is engageable with the rod 125. The air in the housing 121 is compressed by the piston 123 sufficiently to provide a predetermined upward force on the cam housing 59. For example, this upward force may equal the weight of the vertically reciprocated parts of the press 21 such as the platen 99, the draw rods 101, the cam housing 59, etc.

This permits the cams 51 and 53 to operate on, in effect, a zero weight mass.

Operation of the Press

In operation, the cams 51 and 53 are rotated by the motor 31 which drives the air clutch and brake 33, and the camshaft 37. The lifting cam 51 cooperates with its follower 55 to periodically raise the platen 99 and the lowering cams 53 cooperate with their followers 57 to periodically lower the platen 99. The cams 51 and 53 are arranged and contoured so that the platen is reciprocated through two full cycles for each revolution of the cams; however, other ratios between camshaft revolutions to platen cycles can be employed.

More specifically, power is transmitted from the cam followers 55 and 57 through the shoes 61 and 63, respectively, to the cam housing 59. The reciprocatory motion of the cam housing 59 is transmitted by the screw 87 and the nut 89 to the draw rod platen 85. The draw rod platen 85 in turn drives the draw rods 101 to reciprocate the platen 99.

The motor 97 can turn the worm 95 to rotate the nut 89 while the press is being run to thereby adjust the spacing between the platen 99 and the cams 51 and 53. Thus, the location of the platen at the beginning and end of its stroke can be adjusted.

The Forming Cams

Forming cams 129 and 131 (FIGS. 2, 3, 5 and 6) are mounted for rotation on shafts 133 and 135, respectively. The shafts 133 and 135 are in turn suitably mounted for reciprocation in the bed 111 of the press 21.

The forming cams 129 can be rotated in different ways. In the embodiment illustrated, the forming cams 129 are rotated by the main drive motor 31. Specifically, the drive train for the forming cams 129 includes a pinion 137 (FIG. 1) mounted on the camshaft 37, idler gears 139 and 141 mounted on shafts 143 and 145, respectively, a gear 147 mounted on a shaft 149
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(FIGS. 1 and 4), and a toothed belt 151 extending between gears 153 and 155 mounted on the shafts 149 and 133, respectively.

The forming cams 131 can be driven in different ways. However, in the embodiment illustrated, these forming cams 131 are driven by the main drive motor 31 through a portion of the feeding device 29, and this is described hereinbelow in connection with the feeding devices 29.

The forming cams 129 and 131 can be used in various ways and with various tools to provide a stroke which is perpendicular to or at an angle relative to the direction of movement of the platen 99. FIG. 6 shows by way of example one way in which the forming cams 129 and 131 can be used. In FIG. 6, the forming cams 129 and 131 cooperate with cam followers 157 to operate forming tools 159 which are mounted in guides 161. In the embodiment illustrated, the forming tools 159 have curved working surfaces adapted to curl a part 163. The forming cams 159 can be returned and are maintained against their respective forming cams 129 and 131 by suitable spring units 165 which cooperate with the guides 161. As the forming cams 129 and 131 are driven by the main press motor 31, the operation carried out thereby can be sequenced relative to the work operation performed by the tools carried by the platen 99.

The Stock Feeding Device — Drive For Forming Cam 131

The stock feeding device 29 is useable with the press 21 or with other devices. In the embodiment illustrated, the feeding device 29 is located on the same side of the press as the side from which the stock is being supplied. However, it could be located on the opposite side of the press. Alternatively, separate feeding devices 29 could be located on opposite sides of the press and appropriately sequenced to further increase the speed of the stock feeding operation.

The stock feeding device 29 includes a housing or supporting structure 175 (FIG. 4) appropriately mounted between the press 21. The stock feeding device 29 is driven by the shaft 149 (FIG. 4) of the press. Specifically, the feeding device 29 includes a stub shaft 144 coupled to the shaft 149 by a coupling 179. A gear 181 (FIG. 4) of the press is driven by a drive train which includes the stub shaft 177, a gear 183 mounted on the stub shaft, a gear 184 (FIG. 13) mounted on a rotatable shaft and meshing with the gear 183, a gear 185 mounted on the rotatable shaft 187, a toothed belt 189 meshing with the gear 185 and a gear 190 mounted on another rotatable shaft 191 (FIGS. 4 and 13), a gear 193 mounted on the shaft 191, a gear 195 meshing with the gear 193 and mounted on a stub shaft 197, and a coupling 199 joining the stub shaft 197 to a stub shaft 200 on which the gear 181 is mounted. The forming cams 131 are driven by the gear 181 through a toothed belt 198 (FIG. 3) which extends from the gear 181 to a gear 196 on the shaft 135. Thus, the forming cams 131 are driven by the main drive motor 31 of the press through a drive train provided in part by the feeding device 29. If the feeding device is located on the opposite end of the press, the shaft 197 is driven directly by a coupling 179a, the shaft 177 is driven by the shaft 197, and drive train just described, and the lift cams 321 and 319 (described hereinbelow) are reversed to reverse the stock feeding direction. In this event the shaft 177 drives a gear 181a which is coupled through a toothed belt (not shown) to another gear 196a (FIG. 3) on the shaft 135. Thus, regardless of the end to which the feeding device 29 is attached, the forming cams 131 can be appropriately driven.

The Stock Feeding Device — Multiple Shuttle Motion

FIGS. 7–12 illustrate schematically the multiple shuttles of the feeding device 29. As shown in FIG. 7, the feeding device includes an upper shuttle member 201 and a lower shuttle member 203 forming one shuttle. An upper shuttle member 205 and a lower shuttle member 207 form a second shuttle. Each of the shuttles is adapted to feed stock 208 for various purposes such as to a work station defined by a punch 209 and a die 211. The punch 209 is reciprocated by the platen 99 of the press 21. Although the punch 209 and the die 211 are adapted to perform a piercing operation, obviously the feeding device 29 is in no way limited by the type of work operation which is ultimately performed on the stock 208.

In the position shown in FIG. 7, the shuttle members 201 and 203 are out of clamping engagement with the stock 208 and the shuttle members 205 and 207 clampingly engage the stock. The punch 209 is out of the die 211 and out of contact with the stock 208.

In FIG. 8, the shuttle members 205 and 207 remain in clamping engagement with the stock 208 and the shuttle members 201 and 203 have been moved into clamping engagement with the stock. When the stock 208 is gripped by all four of the shuttle members, the punch 209 is advanced through the stock 208 and into the die 211 to pierce an aperture 212 (FIG. 9) in the stock. Preferably, both of the shuttles clampingly engage the stock 208 during the entire piercing movement shown in FIG. 8; however, if desired, one of the sets of shuttles may release the stock during a portion of or all of the piercing operation shown in FIG. 8.

Next, the punch 209 is withdrawn from the aperture 212. Preferably, both sets of shuttles tightly clamp the stock 208 during the stripping or withdrawal action shown in FIG. 9. Following the stripping operation of FIG. 9, the shuttle members 205 and 207 are moved out of clamping engagement with the stock 208 as shown in FIG. 9. The shuttle members 201 and 203 remain in clamping engagement with the stock during this time.

Next, the shuttle members 201 and 203 are moved to the left to index the stock 208 through the work station to provide a first indexing movement for the stock. Substantially simultaneously, the shuttle members 205 and 207 move in the opposite direction, i.e., to the right as viewed in FIG. 10.

Next, the shuttle members 205 and 207 move into clamping engagement with the stock 208 while the shuttle members 201 and 203 remain in clamping engagement with the stock (FIG. 11). With the stock 208 securely clamped between both of the shuttles, the platen 99 is advanced to move the tool 209 through the stock and into the die 211 to form a second aperture 212a (FIG. 12) in the sheet material. Except for the relative positions of the shuttle members, the operation of FIG. 11 may be identical to the operation of FIG. 8.

With all of the shuttle members securely clamping the stock 208, the punch 209 is removed from the stock as shown in FIG. 12. Following this stripping operation,
the shuttle members 201 and 203 are moved out of the clamping engagement with the stock and the shuttle members 205 and 207 remain in clamping engagement with the stock. The shuttle members 205 and 207 are then advanced to the left to index sheet material through the work station for the second time and simultaneously the shuttle members 201 and 205 are moved to the right. Upon the completion of these movements, the shuttle members are in the positions shown in FIG. 7. This marks the completion of one full cycle of operation during which time the sheet material has been indexed two times and the punch 209 has been operated twice to perform two work operations on the stock. The sequence of operation of the shuttle members described above is preferred; however, obviously other sequences of operation can be utilized.

An important advantage of the described sequence of operation is that one set of shuttles is feeding stock while the second set of shuttles makes its return or retrograde movement. With this arrangement, there is no "down time" while one set of shuttles makes its return movement. Another advantage is that the stock can be tightly gripped by two sets of shuttles, if desired, during the work operation to assure that the work operation will not cause inadvertent movement of the stock 208.

The Stock Feeding Device

The feeding device 29 includes a shaft 213 (FIG. 4) having an axial bore 215 and mounted for rotation on the housing 175 by bearings 217. The shaft 213 is drivingly connected to the shaft 187 by a coupling 219 having a spring 221 normally maintaining the coupling engaged. The outer end of the bore 215 is closed by a cover 223 connected to the housing 175. The coupling 219 includes coupling members 224 and 224a with the latter having a closed end 224b which closes the inner end of the bore 215. By removing the cover 223, and inserting a tool through the bore 215 and pressing against the closed end 224b of the coupling member 224a, the force of the spring 221 can be overcome and the coupling 219 disengaged to disconnect the shaft 213 from the shaft 187. This allowed the feeding mechanism and the press to be manually turned independently of each other for set up.

A cam 225 (FIGS. 4 and 17) is mounted on the shaft 215 for rotation therewith. The cam 225 drives an arm or bell crank 227 (FIGS. 14, 17 and 18). The cam 225 in the embodiment illustrated is in the form of a spline and a pair of cam followers 229 and 231 engage opposite faces of the cam. The cam followers 229 and 231 are mounted on a reciprocable slide 233. The cam follower 229 is mounted on the slide 233 by an externally threaded stud 235 which permits the cam follower to be advanced radially of the cam 225 as may be necessary to compensate for wear of the follower. The threaded stud 235 is received in the slide 233 and in a key 237 which is attached by a screw 239 to the slide.

The follower 231 passes through a bore in the slide 233 and is threadedly received by a nut 241 held in a sliding key 243 and locked in position by a lock screw 245. The key 243 is slidable in a slot 247 (FIGS. 14 and 17) in the end of the belt rank 227.

The slide 233 is mounted for reciprocating movement in a direction parallel to the axis of the cam 225 by a plurality of ball bearings 249 (FIG. 17) carried by a plate 251 of the housing 175. The ball bearings 249 may cooperate with longitudinally extending grooves along the longitudinal edges of the slide 233 in a manner described more particularly hereinbelow.

The bell crank 227 is mounted for pivotal movement by an adjustable pivot 253 (FIGS. 14 and 18) on a mounting plate 255 (FIGS. 4 and 14). The adjustable pivot 253 is slidable in a slot 257 in the mounting plate and in a slot 259 in the bell crank 227. The adjustable pivot 253 may be of the type disclosed in my copending application Ser. No. 46,009 which permits movement of the pivot along the slot 257 and hence the movement of the pivotal axis of the bell crank 227 without moving the bell crank.

Rotation of the cam 225 causes the bell crank 227 to oscillate about its pivot axis defined by the adjustable pivot 253. As the cam followers 229 and 231 are attached to the slide 233, the slide reciprocates and causes the cam followers to move along a line parallel to the axis of the cam 225 rather than moving circumferentially of the cam 225 as the bell crank 227 pivots. This is permitted by the key 243 which slides longitudinally of the bell crank 227 as may be necessary to accommodate the pivotal movement of the bell crank.

The end of the bell crank 227 opposite from the cam 225 is drivingly connected in any suitable manner to a reciprocable member in the form of a rack 261 (FIGS. 14 and 18). Thus, oscillatory movement of the bell crank 227 about the adjustable pivot 253 causes the rack 261 to reciprocate. The rack 261 is mounted for linear reciprocating movement by ball bearings 263 carried by the housing 175 and bearings 265 carried by blocks 267 and 269 suitably fixed within the housing 175. The ball bearings 263 and 265 cooperate with longitudinally extending grooves in the rack 261 to mount the latter for rotation. The rack 261 has teeth 271 thereon.

A shaft 273 (FIGS. 14, 15 and 18) is mounted for rotation in the blocks 267 and 269 by bearings 275. A pinion 277 is centrally mounted on the shaft 273 for rotation therewith and for cooperation with the teeth 271 of the rack 261. Pinions 279 and 281 are mounted on the opposite ends of the shaft 273 for rotation therewith and for cooperation with teeth formed on upper rack sections 283 and lower rack sections 285. The rack sections 283 and 285 form sections of reciprocable members 287 and 289, respectively (FIG. 16). The rack sections 283 and 285 are affixed to the opposite portions of the reciprocable members 287 and 289 in any suitable manner such as by screws 291.

Each of the reciprocable members 287 and 289 is mounted for reciprocation by a plurality of ball bearings 293 and 295. The outer ball bearings 295 are mounted in blocks 296 and the inner ball bearings 293 are mounted in blocks 298 and the inner ball bearings 293 are mounted in four spring blocks 297 (FIGS. 13c and 14). The spring blocks 297 are arranged in aligned pairs with each spring block of a pair being mounted for sliding movement toward and away from the reciprocable members 287 and 289 and being retained against movement in other directions. Each of the spring blocks 297 is urged outwardly by a spring 299 to thereby load the inner ball bearings 293 into engagement with the reciprocable members 287 and 289.

As shown in FIG. 13a, each of the reciprocable members 287 and 289 has a longitudinally extending groove 301 extending along the opposite longitudinal edges
thereof. The ball bearings 293 and 295 ride in the grooves 301 to thereby mount the reciprocable members 287 and 289 for a low friction reciprocating movement. This is the same construction that is employed in the preferred embodiment for mounting of the rack 261 and the slide 233.

As shown in FIG. 14, each of the bottom reciprocable members 287 has a longitudinally extending slot 303 in the outer end thereof and each of the top slides 287 has a wider central slot 305.

With this construction, the rack 261 is reciprocated by the bell crank 227. This causes the pinions 277, 279, and 281 (FIG. 15) to oscillate. Because the lower reciprocable members 289 are beneath pinions 279 and 281 and because the upper reciprocable members 287 are above these pinions, the upper and lower reciprocable members are simultaneously moved in opposite directions. The present invention converts this out-of-phase reciprocatory movement of the upper and lower members 287 and 289 into reciprocating or shuttle-like movements of the shuttle members 201, 203, 205 and 207.

As shown in FIG. 13a, each of the lower reciprocable members 289 has a sleeve 307 attached thereto and projecting upwardly through the slot 305 in the upper reciprocable member 287 immediately thereabove. The upper end of the sleeve 307 is affixed to the lower shutter pad 203.

Also as shown in FIG. 13a, a sleeve 309 is attached at its lower end to the upper reciprocable member 287 and at its upper end to the lower shutter member 207. Each of the sleeves 307 and 309 projects through slots 311 in an upper plate 313. The slots 305 and 311 permit the sleeve 307 to reciprocate and the slots 303 (FIG. 14) and 311 permit the sleeve 309 to reciprocate. Thus, reciprocating motion is imparted to the lower shuttle pads 203 and 207.

To provide for clamping and unclamping of the stock and to mount the upper shuttle members 201 and 205 for reciprocation with the lower shuttle members 203 and 205, respectively, lifters 315 and 317 are provided (FIGS. 13 and 14). The lower ends of the lifters 315 and 317 form cams for flat feed cams 319 and 321, respectively. The lifters 315 and 317 extend through the associated sleeves 307 and 309 and are suitably affixed at their upper ends to the upper shuttle members 201 and 205, respectively. As shown in FIG. 13a, the lifter 317 is urged against the cam 321 by a spring 323 which bears against the lifter at one end and against a shoulder defined by a bushing 325 suitably mounted within the sleeve 309. The lifters 315 are similarly spring biased into contact with their cams 319.

The slots 303 in the lower reciprocable members 289 receive the lifters 317 and allow reciprocation thereof in a direction radially of the lifters. The lifters 315 and 317 are reciprocated radially by their associated sleeves 307 and 309 and transmit this reciprocatory motion to the upper shuttle members 201 and 205. The lower ends of the lifters 315 and 317 slide back and forth along the associated cams 319 and 321 as the lifters as reciprocated radially.

As the cams 319 and 321 rotate, they reciprocate the lifters 315 and 317 axially to cause the shuttle members 201 and 205 to move toward and away from the shuttle members 203 and 207. This causes the shuttle members to periodically clamp and unclamp sheet stock. By timing the clamping and unclamping of the sheet stock with the reciprocation of the shuttle members, they can be caused to operate in the manner described hereinabove with reference to FIGS. 7–12 to feed the stock.

The feed cams 319 and 321 can be mounted in various ways. In the embodiment illustrated, one feed cam 319 and one feed cam 321 are mounted on one shaft 327 (FIG. 4) and the other feed cams are mounted on another shaft 329. The shaft 327 is driven by a belt drive 331 from the shaft 213. The shaft 329 is driven by a belt drive 333 from the shaft 327.

The feeding device 29 also includes a pair of hard stops 335 and 337 (FIGS. 14 and 14a). Each of the stops 335 and 337 includes a screw 339 suitably mounted on the housing 175 and a nut 341 mounted on the screw. The rack 261 has an abutment 343 on the opposite face of which is engageable with the nuts 341. The nuts 341 are mounted for movement along parallel paths by outer guides 345 and a central guide 347. The outer guides are mounted on a supporting plate 349 by screws 351 and hold the nuts 341 against rotation.

By turning of the screws 339, the nuts 341 translate in the guides 345 and 347 thereby adjusting the space between flat faces 353 of the nuts 341 and the abutment 343. The faces 353 remain parallel to the abutment 343 as the nuts 341 translate. The nuts 341 can be locked in position by tightening of the screws 351. This clamps a flange 355 (FIG. 14a) of each of the nuts 341 tightly against the supporting plate 349.

Operation of the Feeding Device

Power is supplied to the feeding device 29 from the shaft 149 (FIG. 4) through the coupling 179, a stub shaft 177, gears 183 and 184 (FIG. 13), the shaft 187, a coupling 219, to a cam 225 (FIGS. 17 and 18). Rotation of the cam 225 pivots the bell crank 227 about its pivot 253 to thereby reciprocate a rack 261 (FIG. 18). The rack 261 drives the pinion 277 which is coupled to pinions 279 and 281 through a shaft 273. The pinions 279 and 281 oscillate with the shaft 273 to simultaneously reciprocate the reciprocatory members 287 and 289 in an out of phase relationship. The lower reciprocatory member 289 drives the lower shuttle member 203 through the sleeve 307 (FIG. 13a) and the lower shuttle member 207 is driven by the upper reciprocatory member 287 through the sleeve 309. The feed cams 319 and 321 (FIGS. 4 and 13a) and the lifters 315 and 317 move the upper shuttle members 201 and 205, respectively, up and down the clamp and unclamp the stock. The lifters 315 and 317 also couple the upper shuttle members 201 and 205 to the lower shuttle members 203 and 207, respectively, so that each set of shuttle members can be reciprocated or shuttled together.

The sequencing of the movements of the shuttle members 201, 203, 205 and 207 is as described hereinabove with reference to FIGS. 7–12. The shuttle members can be sequenced with the operation of the platen 99 by disconnecting the coupling 219 (FIG. 4) and turning the shaft 213 relative to the press 21.

The length of the stroke of the shuttle members can be increased or decreased by moving the adjustable pivot 253 toward or away from the cam 225, respectively. In the embodiment illustrated, the length of the strokes of the two shuttles are equal, however, if desired, the stroke lengths could be made unequal by, for example, driving the upper reciprocatory members 287
through speed reduction gearing. If the bearings 293 wear, the springs 229 provide automatic take-up for bearing wear in that they urge the cooperating pairs of the bearings into engagement with the reciprocatory members 287 and 289. The adjustable hard stops 335 and 337 provide a positive limitation on the reciprocatory movement of the shuttle members. The dual feeding action of the shuttle members is accomplished with only a single revolution of the input stub shaft 177 and with only a single oscillation of the bell crank 227.

Although the feeding device 29 has been illustrated with two sets of shuttles, obviously additional shuttles can be added if desired. Similarly, the mechanism illustrated can be used to operate only a single set of shuttles, if desired.

Although an exemplary embodiment of the invention has 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 performing work operations on stock comprising:
   first and second shuttle members on opposite sides of the stock;
   means for moving the first and second shuttle members into clamping relationship with the stock;
   means for advancing said first and second shuttle members from an initial position to an advanced position with the first and second shuttle members being in clamping relationship with the stock to provide a first stock indexing movement;
   third and fourth shuttle members on opposite sides of the stock;
   means for holding the third and fourth shuttle members out of clamping relationship with the stock at least when the first and second shuttle members are being advanced from the initial position to the advanced position;
   means for moving the third and fourth shuttle members from a first position to a second position during at least a portion of the time that the first and second members are being advanced;
   means for moving the third and fourth shuttle members into clamping relationship with the stock when the third and fourth clamping members are at said second position;
   means for moving the third and fourth shuttle members from the second position to the first position with the third and fourth shuttle members being in clamping relationship with the stock to thereby provide a second stock indexing movement;
   means for holding the first and second shuttle members out of clamping relationship with the stock at least when the third and fourth shuttle members are moving from the second position to the first position;
   means for returning the first and second shuttle members from the advanced position to the initial position during at least a portion of the time that the third and fourth shuttle members are being moved from the second position to the first position; and
   means for performing at least one work operation on the stock at the termination of at least one of said stock indexing movements.

2. A press as defined in claim 1 wherein the third and fourth shuttle members are moved into clamping relationship with the stock at said second position before the first and second shuttle members are moved out of clamping relationship with the stock.

3. A press as defined in claim 1 wherein said shuttle members index the stock in the same direction.

4. A press as defined in claim 1 wherein the distance from the initial position to the advanced position is the same as the distance between the first and second positions.

5. A press as defined in claim 1 wherein the distance from the initial position to the advanced position is different than the distance between said first and second positions.

6. A method of working on stock comprising:
   clamping a region of the stock between first and second shuttle members;
   advancing the first and second shuttle members from an initial position to an advanced position with the first and second shuttle members being in clamping relationship with the stock to provide a first stock indexing movement;
   moving third and fourth shuttle members from a first position to a second position during at least a portion of the time that the first and second shuttle members are being advanced;
   holding the third and fourth shuttle members out of clamping relationship with the stock during said step of advancing;
   moving the third and fourth shuttle members into clamping relationship with the stock when the third and fourth clamping members are at said second position;
   moving the third and fourth shuttle members from the second position to the first position with the third and fourth shuttle members being in clamping relationship with the stock to thereby provide a second stock indexing movement;
   holding the first and second shuttle members out of contact with the stock at least during said last mentioned step of moving;
   returning the first and second shuttle members from the advanced position to the initial position during at least a portion of the time that the third and fourth shuttle members are being moved from the second position to the first position; and
   performing a work operation on the stock immediately following each of said indexing movements.

7. A press for performing work operations on stock comprising:
   a supporting structure;
   a platen mounted on the supporting structure for movement relative to the supporting structure;
   means for moving the platen toward and away from the stock whereby work operations can be performed on the stock;
   first and second reciprocating members including first and second rack sections, said reciprocating members being mounted for reciprocation on said supporting structure;
   gear means on the supporting structure and cooperating with said rack sections for driving said reciprocating members in opposite directions;
   first shuttle means driven in a reciprocatory motion by said first reciprocating member for providing successive increments of movements to the stock in
one direction so that the press can perform work operations at various locations along the stock; and
second shuttle means driven in a reciprocatory motion by the second reciprocating member for providing successive increments of movement to the stock with the last mentioned increments occurring intermediate to first mentioned increments and being in said one direction.
8. A press as defined in claim 7 including a driving rack for driving said gear means and means for reciprocating said driving rack.
9. A press as defined in claim 8 wherein said means for reciprocating the driving rack includes an arm, means for mounting said arm on said supporting structure for pivotal movement about a pivotal axis, means for moving the location of said pivotal axis, and means for drivingly connecting the arm to the driving rack.
10. A press as defined in claim 9 including a cam mounted for rotation on said supporting structure, said cam oscillating said arm about said pivotal axis.
11. A press as defined in claim 7 wherein said first shuttle means includes means for selectively clamping and unclamping the stock, a cam mounted for rotation on the supporting structure, and means driven by said cam and carried by said first reciprocating member in the reciprocatory movement thereof for operating said clamping and unclamping means.
12. A press as defined in claim 11 wherein at least a substantial portion of said second reciprocating member is above at least a substantial portion of said first reciprocating member, said second reciprocating member having a slot through which the cam driven means extends.
13. A press as defined in claim 7 including bearing means for mounting said first reciprocating member for reciprocation and spring means for loading at least a portion of said bearing means against said first reciprocating member.
14. A press as defined in claim 7 including drive means for the gear means, said drive means including a rotatable cam mounted for movement about a first pivotal axis and a pivotal arm rotatable about a second pivotal axis generally transverse to the first pivotal axis, and means for coupling the cam to the arm so that as the arm pivots the coupling means moves along a line generally parallel to the first pivotal axis.
15. A press for performing work operation on stock comprising:
a supporting structure;
a platen mounted on the supporting structure for movement relative to the supporting structure;
means for moving the platen toward and away from the stock whereby work operations can be performed on the stock;
a drive member;
means for mounting the drive member for movement through a two-stroke cycle with one of the strokes being in a first direction and with the other of the strokes being in a second direction generally opposite to said first direction;
a first reciprocatory shuttle having a feeding stroke during which the first shuttle indexes the stock through the press and a return stroke;
means for drivingly connecting said drive member and said first shuttle so that said first shuttle is driven through one of said strokes thereof by said drive member during said first stroke;
a second reciprocatory shuttle having a feed stroke during which the second shuttle indexes the stock through the press and a return stroke;
means for drivingly connecting the drive member and the second shuttle so that said second shuttle is driven through one of said strokes thereof by said drive member as said drive member moves through one of said strokes thereof; and
said first and second shuttles sequentially indexing the stock.
16. A press as defined in claim 15 wherein said drive member drives said first and second shuttles through their respective feed strokes on the first and second strokes, respectively, of said drive member, said drive member driving the first and second shuttles through their respective return strokes on the second and first strokes, respectively, of said drive member.
17. A press for performing work operations on stock comprising:
a supporting structure;
a platen mounted on the supporting structure for movement along a path relative to the supporting structure;
drive means for moving the platen through n cycles per predetermined unit of time whereby at least one work operation can be performed on the stock during each of said cycles;
a stock feeding device;
said feeding device including a drive member movable back and forth with one backward and one forward movement defining one cycle of movement of the drive member and means for driving said drive member through no more than n/2 cycles per said predetermined unit of time; and
said feeding device including means driven by said drive member for indexing the stock at least once for each of said forward and backward movements of the drive member.
18. A press as defined in claim 17 wherein said drive member includes a rack mounted for reciprocation and said means driven by said drive member includes at least one gear.
19. A press as defined in claim 17 wherein said drive member includes gear means mounted for oscillatory movement about a pivotal axis and said means driven by said oscillatory member includes first and second racks driven in opposite directions by said gear means.
20. A press as defined in claim 17 wherein said indexing means includes a first set of shuttle members movable into and out of clamping engagement with the stock and reciprocable for indexing the stock one time for each cycle of the drive member and a second set of shuttle members movable into and out of clamping relation with the stock and reciprocable for indexing the stock at least one time for each cycle of the drive member, said first and second sets of shuttle members being operable sequentially.
21. A press as defined in claim 17 including first and second cams, means for mounting said cams on the supporting structure for rotation together;
first and second cam followers;
means for drivingly connecting the cam followers to the platen;
said first cam follower engaging the first cam for driving the platen in one direction along said path; said second cam follower engaging the second cam for driving the platen in the other direction along said path; said cams moving the platen through at least two cycles in response to one revolution of the cams; said cam followers being in constant contact with their respective cams throughout the full angular movement of the cams.

22. A press for performing work operations on stock comprising:
- a supporting structure;
- a platen mounted on the supporting structure for movement relative to the supporting structure;
- means for moving the platen toward and away from the stock to perform work operations thereon;
- first reciprocatory shuttle means movable through a feed stroke and a return stroke for providing a first indexing movement for the stock on said feed stroke thereof;
- second reciprocatory shuttle means movable through a feed stroke and a return stroke for providing a second indexing movement to the stock on said feed stroke thereof; and
- said first and second shuttle means being operated in sequence so that one of said shuttle means is on its feed stroke during at least a portion of the time that the other of the shuttle means is on its return stroke.

23. A press for performing work operations on stock comprising:
- a supporting structure;
- a platen;
- means for mounting the platen on the supporting structure for reciprocating movement along a path, said platen being adapted to carry a tool for performing a work operation on the stock;
- first and second cams;
- means for mounting said cams on the supporting structure for rotation together; and
- said cams moving the platen through at least two cycles in response to one revolution of the cam; and
- said cam followers being in constant contact with their respective cams throughout the full angular movement of said cams.

24. A press as defined in claim 23 wherein said means for mounting the cams includes a rotatable shaft on which both of the cams are mounted.

25. A press as defined in claim 24 wherein said coupling means includes an adjustable means for adjusting the position of the platen relative to said cams while the press is running.

26. A press as defined in claim 24 including an air cylinder for supporting at least part of the weight of the coupling means.

27. A press as defined in claim 23 wherein said platen mounting means includes a plurality of draw rods coupled to said platen and at least one ball cage for mounting each of said draw rods for reciprocating movement on the supporting structure.

28. A press as defined in claim 23 including drive means for rotating said cams, a stock feed including first shuttle means driven by said drive means for indexing the stock one time for each revolution of said cams, and second shuttle means driven by said drive means for indexing the stock one time for each revolution of said cams.

29. A press for performing work operations on stock comprising:
- a supporting structure;
- a platen;
- means for mounting the platen on the supporting structure for reciprocating movement along a path, said platen being adapted to carry a tool for performing a work operation on the stock;
- a rotatable drive element; and
- drive means for driving said drive element;
- means for coupling the drive element and the platen so that the drive element can drive the platen;
- said coupling means including adjustable means for adjusting the position of the platen relative to the drive element in a direction along said path while the press is running;
- said coupling means including a screw, a nut cooperable with the screw, and means for relatively rotating the nut and screw;
- said means for relatively rotating the screw and the nut including a first gear on said nut, a second gear, and motor means for driving said second gear; and
- said platen including means for reciprocating draw rods, said coupling means including a draw rod platen coupled to said draw rods, said nut being rotatably mounted on said draw rod platen, said screw being drivenly coupled to said drive element.

30. A press for performing work operations on stock comprising:
- a supporting structure;
- a plurality of draw rods mounted on said supporting structure for generally vertical movement relative thereto;
- an upper platen mounted on said draw rods for movement therewith;
- at least one drive cam rotatably mounted on the supporting structure; and
- means for rotating said drive cam;
- means including a cam follower engageable with said drive cam and a draw rod platen coupled to said draw rods for drivingly connecting the drive cam with the draw rods whereby the drive cam can drive said draw rods and said platen generally vertically;
- at least one forming cam mounted on said supporting structure adjacent said upper platen for movement relative to the supporting structure, said forming cam being adapted to drive a forming member generally horizontally; and
- means other than said draw rods for drivingly coupling said forming cam to said rotating means whereby the rotating means can drive said forming cam.
31. A press for performing work operations on stock comprising:
   a supporting structure;
   a plurality of draw rods mounted on said supporting structure for movement relative thereto; 5
   at least one cam rotatably mounted on the supporting structure;
   means for rotating said cam;
   a cam housing mounted on said draw rods;
   a cam follower carried by said cam housing and co-operative with said cam whereby rotation of said cam moves said cam follower and said cam housing;
   a draw rod platen; 10
   means for affixing said draw rod platen to said draw rods whereby said draw rod platen and said draw rods are movable together;
   a nut member mounted on one of said cam housing and said draw rod platen and a screw member mounted on the other of said cam housing and said draw rod platen, at least one of said members being rotatable and including a first gear;
   a second gear co-operative with said first gear to drive said one member to thereby adjust the position of the draw rod platen relative to the cam housing; 15
   motor means for driving said second gear; and
   an upper platen affixed to said draw rods.

32. A press for performing work operations on stock comprising:

   a supporting structure;
   a platen mounted on the supporting structure for movement relative to the supporting structure;
   means for moving the platen toward and away from the stock whereby work operations can be performed on the stock;
   upper and lower carriages mounted on said supporting structure for reciprocating movement;
   means for reciprocating said carriages in an out-of-phase relationship;
   a first set of shuttle members carried by said upper carriage and reciprocable therewith;
   a second set of shuttle members carried by said lower carriage and reciprocable therewith;
   means for moving said first shuttle members into and out of clamping relationship with the stock, said last mentioned means including a cam below said carriages and a lifter driven by said cam and extending through said carriages;
   means for moving said second set of shuttle members into and out of clamping engagement with the stock, said means for moving said second set of shuttle members including a cam below said carriages and a lifter driven by said last mentioned cam and extending through said carriages; and
   each of said sets of shuttles being adapted to feed stock to the press.