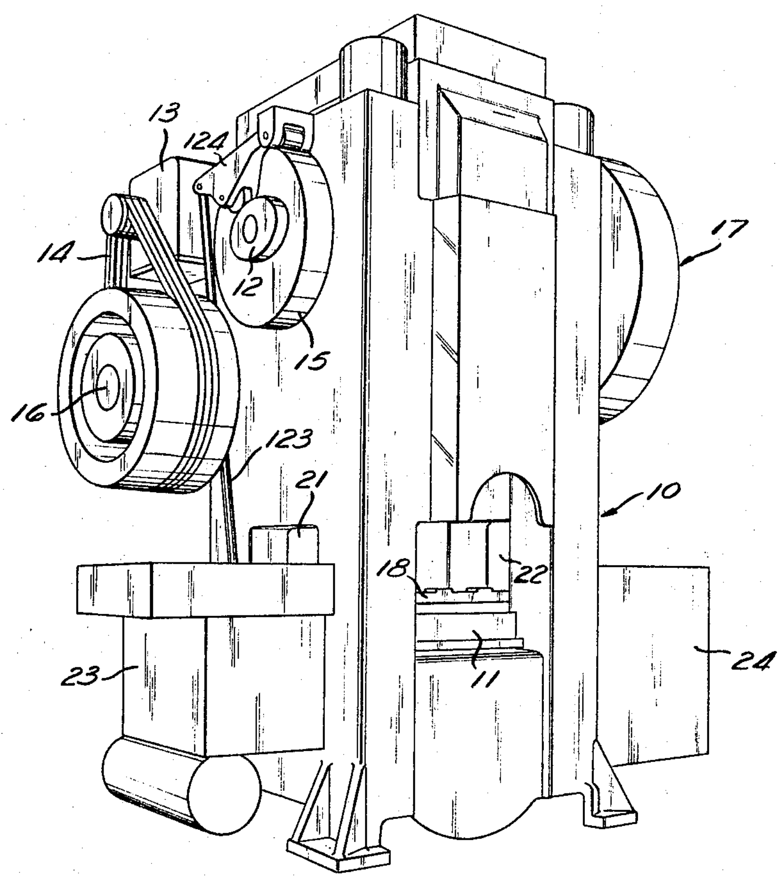

Fig. 1

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Jan. 21, 1969 W. J. GROMBKA ET AL 3,422,657

PRESS TRANSFER MECHANISM

Filed April 22, 1966

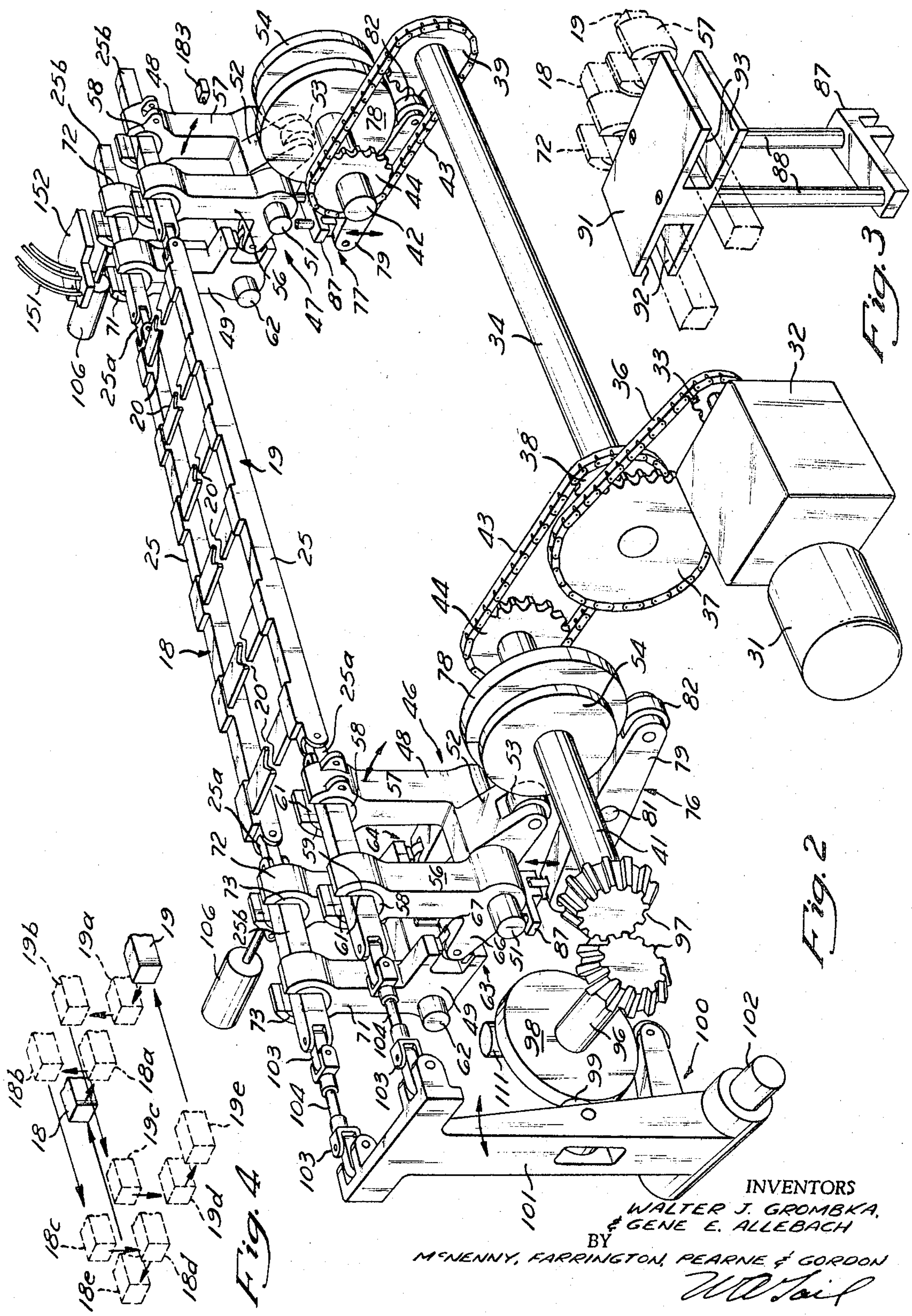

Fig. 2

Fig. 3

Fig. 4

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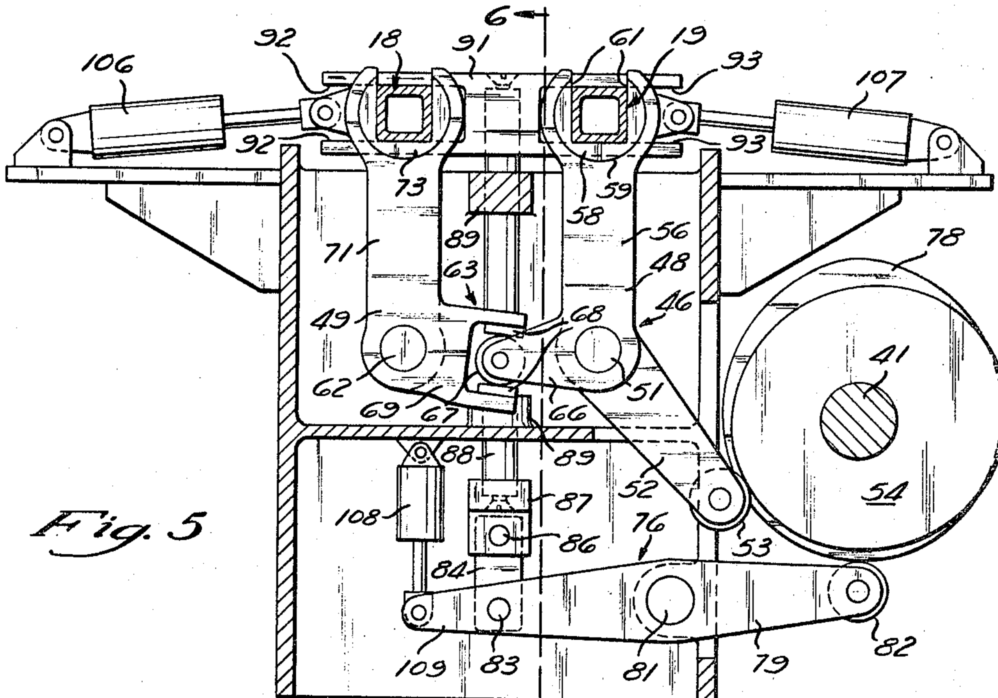

Fig. 5

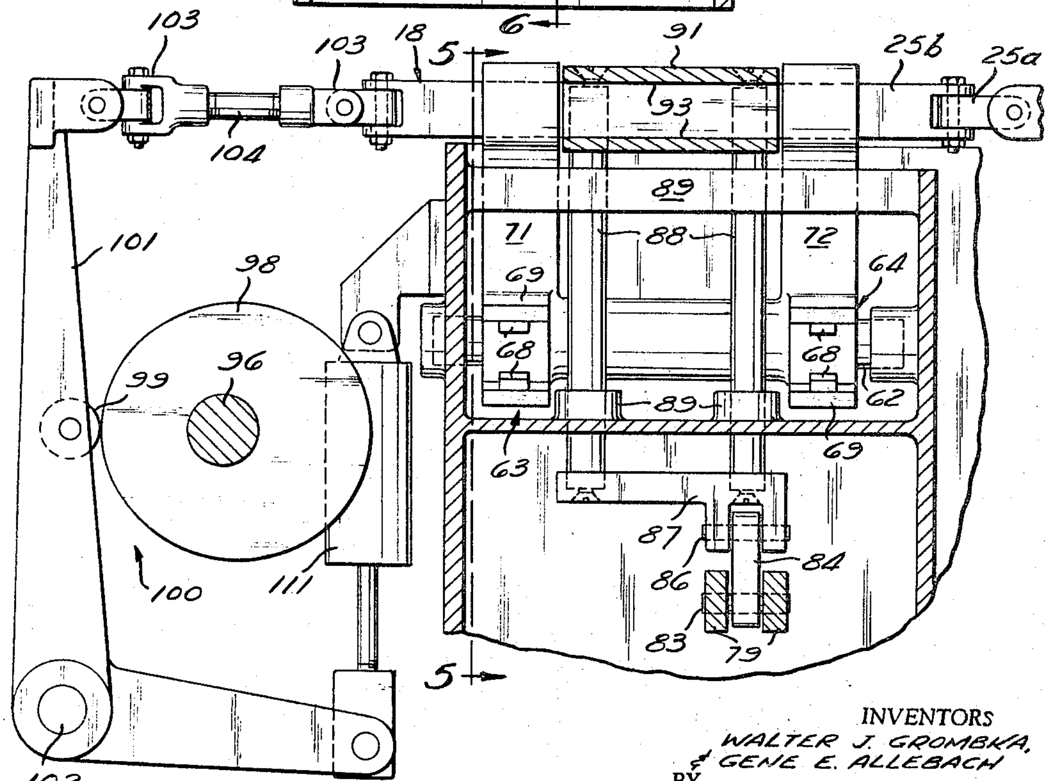

Fig. 6

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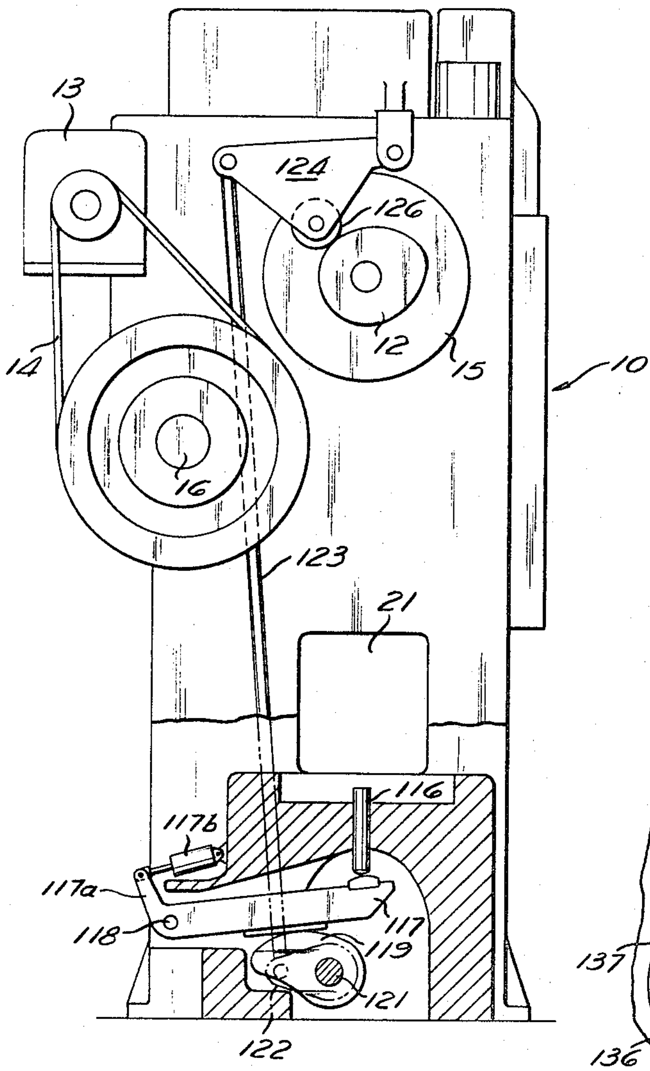

Fig. 7

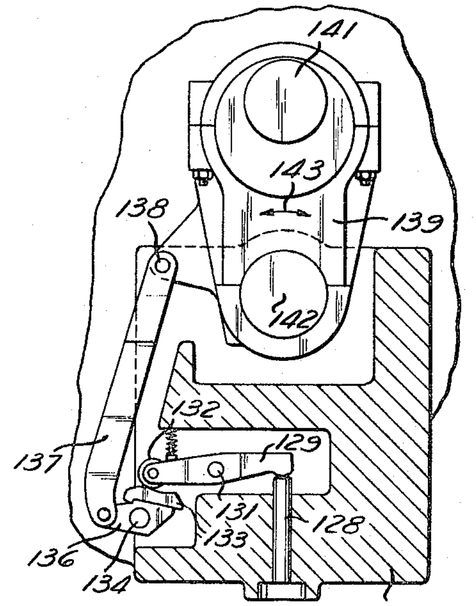

Fig. 8

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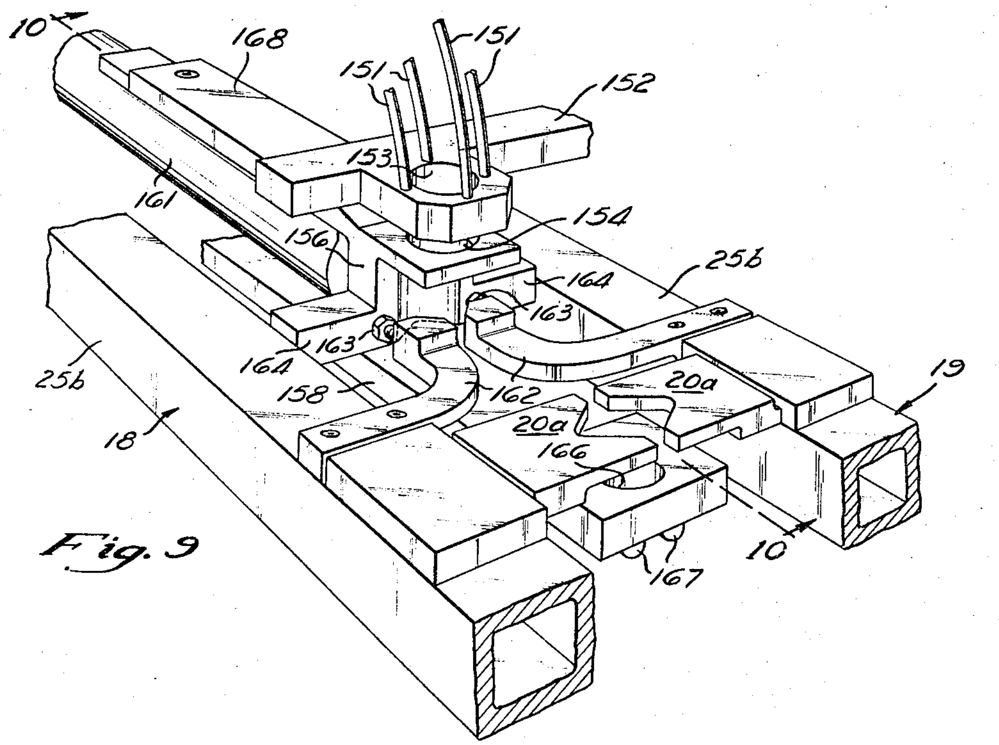

Fig. 9

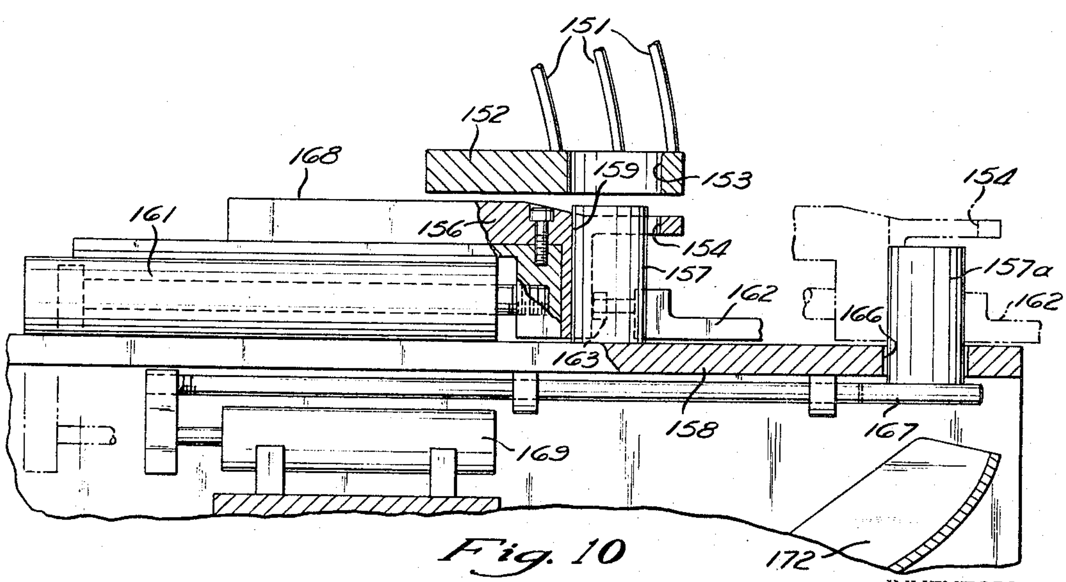

Fig. 10

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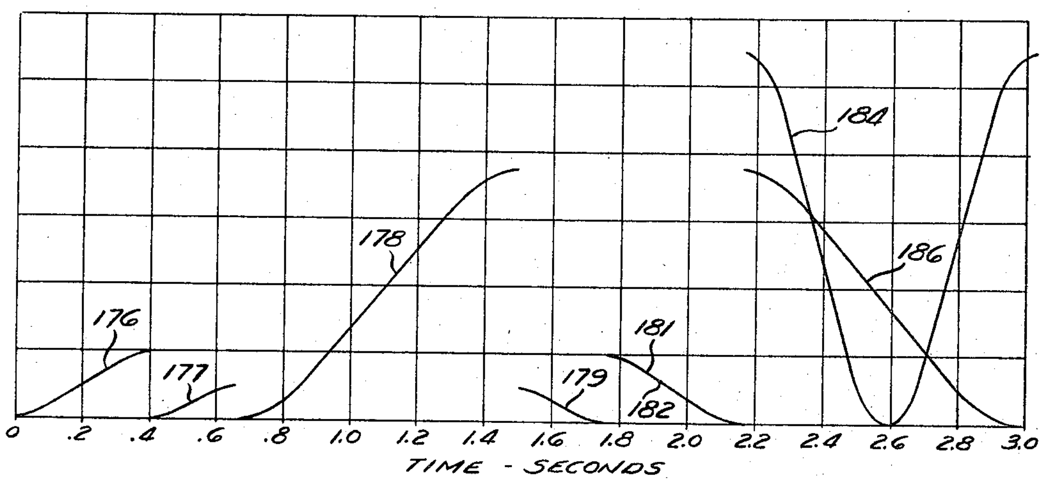

Fig. 11

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3,422,657
PRESS TRANSFER MECHANISM

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U.S. Cl. 72—405 17 Claims
Int. Cl. B21j *11/00;* B21d *43/02, 43/20*

ABSTRACT OF THE DISCLOSURE

A transfer for a forging machine is disclosed which includes two horizontally extending beams which support a plurality of gripper elements adapted to progressively transfer blanks between die stations of a vertical forging press. Three separate drives are connected to move the beams through a cycle of operation wherein the beams move forward to grip a blank, subsequently move vertically to lift the blank from the dies, subsequently move horizontally to position the blank over a subsequent die, subsequently lower to position the blank in the subsequent die, subsequently move apart to release the blank and clear the dies, and finally move back horizontally to the initial position. The drives are all cam actuated from a single power source and are each arranged to operate without affecting the operation of the other drives. The beams are supported at both ends by the drives for vertical and lateral horizontal movement and are connected at one end to the drive for producing longitudinal movement. The transfer also operates a feed mechanism for feeding blanks into the first die and operates to initiate press operation after the transfer operation is complete.

This invention relates generally to automatic forging machines for progressively forming blanks and more particularly to a novel and improved transfer for such machines.

The present invention is illustrated installed upon a large vertical forging machine which is operable to progressively hot forge blanks of substantial size. The blanks are automatically supplied from a furnace to the machine and then automatically transferred sequentially through a series of die stations in each of which the blank is progressively worked. In such machines a completed blank is produced each time the machine operates through one cycle.

The illustrated machine incorporating this invention is provided with a vertically extending frame having a horizontal die breast located adjacent to the base of the machine. A ram is reciprocable in the frame toward and away from the die breast and an intermittent drive including a clutch and brake mechanism is operable to drive the ram down from its top dead center position through its bottom dead center position and back up to its dead center position bringing the ram to rest at the top dead center position each time the clutch and brake mechanism is activated.

The transfer mechanism operates continuously and activates the clutch and brake mechanism of the ram drive at the completion of each transfer operation. The timing of the machine is such that the ram cycle occurs while the transfer mechanism is clear of the dies on its return stroke.

In order to provide a transfer which can function at a relatively high cyclic rate in spite of the fact that the transfer is relatively large and must transfer relatively heavy blanks, a transfer incorporating the present invention is arranged so that the various required movements are produced by separate drive mechanisms. Each drive functions independently but in time relation to the other drive mechanisms. With such an arrangement the mass

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of the moving parts is minimized and higher operating seeds can be maintained. The transfer motion is rectilinear and is arranged so that all unnecessary travel is eliminated. This also permits increased operating speeds and improves operating accuracy.

The transfer includes a pair of substantially parallel beams which extend across the machine past the die stations. These beams are supported on their ends for rectilinear movement in three directions each of which is perpendicular to the other two directions. Gripping means are mounted on the beams and are arranged to progressively grip and move the blanks to each die station. Because the beams are supported on their ends and because the actuating mechanisms are located at the ends of the beams the front portion of the machins is substantially clear of obstruction. This provides the operator with the opportunity to clearly observe the die area of the machine and also provides him with easy access into such area.

During the first phase of transfer beam motion the beams are moved toward each other bringing the gripper means into gripping engagement with the blanks at each die station. As soon as gripping is completed the beams are moved in a direction normal to the die breast lifting the blanks clear of the dies. After the blanks are clear of the dies the beams are longitudinally moved in a forward direction transversely along the die breast to carry the blanks into a position immediately adjacent to the subsequent die station. The beams are then moved in a direction normal to the die breast and toward the die breast to position the blanks in the dies of a subsequent die station. The beams are then moved apart to release the blanks. While the beams are moving apart to release the blanks a control is operated which activates the ram drive so that the ram begins to move downward by the time the transfer beams reach their fully open position. The beams are then longitudinally moved transversely of the die breast back to the initial position completing the cycle of transfer operation. While this occurs the ram operates through a cycle and performs the working operation on the blanks.

Ejectors are provided in the dies and tools. The tool ejectors insure that blanks do not stick in the tools as the ram retracts. The die ejectors lift the blanks to a position in which they can be gripped for transfer. The ejectors are operated by the ram drive during the upstroke of the ram so that the complete working stroke and ejection occurs while the transfer is returning transversely to its initial position.

A sixteen-hundred ton press incorporating the present invention, having five working stations therein, has been satisfactorily operated at twenty cycles per minute and even higher speeds in the order of thirty cycles per minute are believed to be practical.

It is an important object of this invention to provide a forging machine including novel and improved transfer means for automatically transferring blanks to a plurality of die stations.

It is another important object of this invention to provide a novel and improved cyclically operable forging press including a transfer mechanism operating with rectilinear movement and wherein separate drive means are provided to power each direction of transfer movement.

It is another important object of this invention to provide a novel and improved transfer apparatus according to either of the preceding objects which includes a pair of substantially parallel transfer beams mounted for rectilinear movement in three directions each perpendicular to the other two directions so that wasted motion is virtually eliminated.

It is another important object of this invention to provide a novel and improved machine according to the last preceding object wherein the beams are supported on their ends and are provided with similar drives at each end to produce the lateral movements of such beams, and a single drive at one end produces longitudinal beam movement.

It is another important object of this invention to provide a machine according to any of the preceding objects wherein the drives for the transfer are arranged so that the individual drives have a relatively small inertia and wherein the transfer system can be operated at a relatively high cyclic rate.

It is another important object of this invention to provide a forging machine according to any of the preceding objects wherein transfer means are provided to sequentially transfer blanks through a plurality of working stations and wherein the feed of blanks into the machine is controlled by the transfer movement.

It is another important object of this invention to provide a novel and improved article forging press having a horizontally disposed die breast with a plurality of die stations therein in combination with a transfer including a pair of substantially parallel transfer beams supported and driven for rectilinear movement to minimize wasted motion and to permit relatively high speed operation.

It is another important object of this invention to provide a machine according to the last preceding object wherein the structure is arranged to provide a high degree of accessibility to the area of the die breast.

Further objects and advantages will appear from the following description and drawings, wherein:

FIGURE 1 is a perspective view of a vertical press incorporating the present invention;

FIGURE 2 is a schematic, perspective view, with parts removed for purposes of illustration showing the general structural arrangement of the transfer and transfer drives;

FIGURE 3 is an enlarged, fragmentary, perspective view of the vertical drive operator;

FIGURE 4 is a schematic illustration of the movement pattern of the transfer beams;

FIGURE 5 is an enlarged, fragmentary, cross section illustrating two of the drive mechanisms, the first of which operates to open and close the transfer and the second of which operates to raise and lower the transfer;

FIGURE 6 is an enlarged, fragmentary, cross section of the drive mechanism which moves the transfer beams in their longitudinal direction transversely with respect to the press;

FIGURE 7 is a schematic side elevation partially in section illustrating the drive for the die ejector pins;

FIGURE 8 is a fragmentary view, partially in cross section, of the drive for the ejectors in the ram;

FIGURE 9 is a fragmentary, perspective view of the blank feed mechanism which controls the feed of the heated blanks into the machine;

FIGURE 10 is a fragmentary cross section of the feed mechanism taken generally along **10—10** of FIGURE 9; and

FIGURE 11 is a timing diagram for the machine.

Referring to FIGURE 1, the illustrated press includes a frame **10** having a horizontally extending die breast **11** mounted thereon. A ram is supported in the frame for vertical reciprocation toward and away from the die breast **11** and is driven by a crankshaft having a cam **12** mounted on the end thereof. The crankshaft is driven by a motor **13** through a belt drive **14**, a countershaft **16**, and a clutch mechanism **17**. A brake **15** is mounted on the end of the crankshaft opposite the clutch **17**.

The clutch **17** and brake **15** are arranged to drive the chankshaft through one revolution each time the clutch and brake controls are activated. The various elements are arranged so that the cycle commences and ends with the ram in its top dead center position.

The transfer mechanism includes a pair of parallel

beams **18** and **19** which extend above the die breast **11** and through side openings **21** and **22** in the frame **10**. Only the beam **18** appears in FIGURE 1. Covers or cabinets **23** and **24** are mounted on opposite sides of the machine and enclose the drive mechanism for the beams **18** and **19**. With this arrangement the front of the press is completely free of transfer structure and the press operator is provided with an opportunity to easily see the entire working area. In addition, the area of the die breast is easily accessible.

Referring now to FIGURES 2 through 6, the beams **18** and **19** are supported on their ends for rectinlinear movement in a manner best illustrated in FIGURE 4. Each of the beams **18** and **19** is an assembly including a central section **25** supported at each end by a pivoted link ***25a*** and a support bar ***25b***. Each of the support bars ***25b*** extend through associated portions of the transfer drive as discussed in detail below. This arrangement permits removal and replacement of the central sections without disassembly of the drives. Also, the links ***25a*** provides a structure which accommodates slight misalignment between the various drives. At the beginning of each cycle the beams **18** and **19** are in the position represented in full line in FIGURE 4. During the first phase of transfer movement the two beams **18** and **19** move horizontally toward each other to the phantom line positions ***18a*** and ***19a***, respectively. During this phase of movement grippers **20** supported on the beams **18** and **19** engage and grip the blanks for transfer movement. The grippers **20** are spring loaded relative to the beam in the direction of gripping.

During the second phase of transfer movement the beams **18** and **19** move vertically away from the die breast between the respective positions ***18a*** and ***18b*** and the positions ***19a*** and ***19b***. During this phase of the movement the blanks are lifted out of the dies at each of the die stations so that they are clear for transverse movement to the subsequent die station. The beams **18** and **19** are then moved longitudinally transverse of the die breast to the positions ***18c*** and ***19c***, respectively. At this point in the transfer cycle the blanks are located directly above the subsequent die stations.

The beams **18** and **19** are then moved vertically downward, as indicated by the arrows, to the locations ***18d*** and ***19d***, respectively. This movement carries the blanks down into the subsequent die station in position for the next forming operation. At this point in the transfer cycle the beams **18** and **19** move apart to the positions illustrated at ***18e*** and ***19e***, respectively. This causes the grippers to release the blanks and move clear of the tools on the ram. The final movement of the two beams **18** and **19** is longitudinal transversely of the die breast back to their initial positions illustrated in full line. It is during the lateral movement in a horizontal direction to relase the blanks that the ram controls are actuated to initiate one cycle of ram operation. Preferably, the controls are arranged so that the downward movement of the ram commences no later than the time when the beams may reach the positions ***18e*** and ***19e*** and preferably the cycle of ram operation is completed by the time the beams return to their initial position.

Three separate drive mechanisms are provided to produce the transfer beam movement. The drive mechanism for producing lateral beam movement in a horizontal direction includes similar drives with one at each end of the beams within the cabinets **23** and **24**. This is also true of the drive for producing vertical lateral movement of the beams. The longitudinal or transverse movement of the beams, however, is provided by a single drive mechanism located in the cabinet **24**.

FIGURE 2 illustrates the general arrangement of the transfer mechanism with parts removed for purposes of illustration. The power for operating the transfer is provided by an electric motor **31** connected to a gear reducer **32** having an output drive sprocket **33**. The sprocket **33** drives a cross shaft **34** through a chain **36** and a sprocket

37. The cross shaft **34** is located on the back of the machine and is connected to operate the drive mechanisms at the ends of the beams **18** and **19**. The drive mechanism located at the left side of FIGURE 2 is housed within the cabinet **24** and the drive mechanism located at the right side of FIGURE 2 is housed in the cabinet **23**.

A pair of drive sprockets **38** and **39** are mounted at spaced points on the cross shaft of **34** and are connected to drive a first camshaft **41** and a second camshaft **42**, respectively, through chains **43** and sprockets **44**. The drives for the two camshafts **41** and **42** are proportioned so that they rotate at the same speed and in a fixed orientation relative to each other. Therefore, the operation of the drive mechanisms which are powered by the two camshafts is synchronized.

The horizontal lateral movement of the beams **18** and **19** is controlled by similar drive linkages **46** and **47** with one located substantially adjacent to each end of the beams **18** and **19**. Each of these drive linkages **46** and **47** includes a first drive link **48** and a second drive link **49**. The first drive link **48** is pivoted on the machine frame for rotation about the axis of a pivot shaft **51** and is provided with an arm **52** supporting a cam follower **53**. The cam follower **53** engages a cam **54** mounted on the associated camshaft **41** or **42**. The cam **54** is shaped so that it causes oscillating movement of the link **48** about its pivot shaft **51** as the cam is rotated by its camshaft.

The links **48** are also formed with spaced upstanding arms **56** and **57** each of which supports a U-shaped bearing member **58** journaled in the upper end of the associated arm. The bearing members **58** are provided with a circular outer bearing wall mating with a bearing surface in the associated arm so that each of the bearing members **58** is free to rotate about the axis of the outer bearing surface **59** relative to the associated arm **56** or **57**. The bearing members **58** also provide opposed parallel, inner bearing surfaces **61** which engage opposite sides of the beam **19** and permit vertical movement of the beam **19** with respect to the two first links **48**.

The second links **49** are pivoted on the machine frame for rotation about the axis of a pivot shaft **62** and are connected to the first links **48** by a pair of spaced drivers **63** and **64**. These drives are similar and their structure is best illustrated in FIGURE 5. The drives include an arm **66** on the first link **48** supporting a roller **67**. The roller is positioned between opposed bearing blocks **68** carried by an arm **69** on the second link **49**. The zone of engagement between the roller **67** and the bearing blocks **68** is located substantially midway between the axes of the pivot shafts **51** and **62**. Consequently when the first link **48** rotates in a clockwise direction from the position illustrated in FIGURE 5 the second link **49** rotates in an anticlockwise direction through an arc substantially equal to the arc of rotation of the first link. Therefore, rotation of the cam **54** causes substantially equal but opposite movement of the two links **48** and **49**. The link **49**, like the link **48**, is provided with two upstanding arms **71** and **72** similar to the arms **56** and **57**. Here again, a bearing member **73** is mounted in each of the arms **71** and **72** to provide a connection with the beam **18**.

Since the two drive linkages **46** and **47** are similar and connect to the opposite ends of the beams **18** and **19** and since these linkages are driven by synchronized identical cams **54**, these two drive linkages operate to produce lateral horizontal movement of the two beams **18** and **19** both for gripping and release of the blanks.

The lateral movement of the beams **18** and **19** in a vertical direction normal to the die breast is provided by similar third and fourth drive linkages **76** and **77**, respectively. The third drive linkage **76** is located at one end of the beams **18** and **19** and is driven by a cam **78** on the camshaft **41**. Similarly, the fourth drive linkage **77** is located at the other end of the transfer beams **18** and **19** and is driven by a cam **78** on the camshaft **42**.

In FIGURE 2 these drive linkages have been broken

away for purposes of illustration, so reference should be made to FIGURES 3 and 5. The drive linkage **76** includes a follower arm **79** pivoted at **81** on the frame of the machine and provided with a cam follower **82** which engages the associated cam **78**. The other end of the follower arm **79** is pivotally connected at **83** to a connecting link **84** which is in turn pivoted at **86** to a bracket **87**. The bracket **87** is mounted on the lower end of a pair of spaced rods **88** (best illustrated in FIGURES 3 and 6) which extend through spaced guide bearings **89** on the machine frame.

Mounted on the upper ends of the rods **88** is a saddle member **91** having opposed pairs of horizontal extending surfaces **92** and **93** which engage upper and lower surfaces of the beams **18** and **19**, respectively. These saddle members control the vertical position of the associated ends of the beams **18** and **19** and since the two drive linkages **76** and **77** are identical and are driven by synchronized identical cams **78**, they operate to raise and lower the two ends of the beams **18** and **19** in a synchronized manner.

The longitudinal movement of the bars **18** and **19** transversely with respect to the die breast **11** is provided by a single drive linkage **100** connected to one end of each of the beams and located within the cabinet **24**. This drive linkage includes a third cam shaft **96** driven by the camshaft **41** through miter gears **97**. Mounted on the camshaft **96** is a disc cam **98** which engages a roller follower **99** journaled on a drive link **101**. The drive link **101** is pivoted on the machine frame by a pivot shaft **102** and is provided with a T section at its upper end. One end of the T section is connected through a pair of universal joints **103** and a link **104** to one end of the beam **18** and the other end of the T is connected through similar universal joints **103** and link **104** to the adjacent end of the beam **19**. The two links **104** are preferably provided with opposed threads at their ends so that they can be used in the manner of a turnbuckle to adjust the two beams **18** and **19** in a longitudinal direction.

Pneumatic springs are provided to resiliently urge each of the linkages in a direction causing engagement of the respective cam followers and cams. The linkages **46** and **47** are provided with two pneumatic springs **106** and **107** with the spring **106** connected to the second link **49** and the spring **107** connected to the first link **46**. These springs resiliently urge the linkages and in turn the beams **18** and **19** in a closing direction and are overcome by the action of the cams **54**. Consequently the gripping direction of movement of the beams **18** and **19** is produced by springs rather than a positive drive. This prevents overloading in the event of jamming or the like.

A pneumatic spring **108** is connected to a projection **109** on the follower arm **79** and resiliently urges the saddles **91** in a downward direction. Consequently the downward movement of the beams **18** and **19** results from the action of the springs **108** and jamming, or the like, cannot produce overloading on the transfer.

The spring **111** is connected to the link **101** and biases that link in a direction tending to move the beams **18** and **19** in the longitudinal return direction.

The rectilinear movement of the transfer beams **18** and **19** is provided by properly shaping the cams **54**, **78** and **98**. The cams **54** provide the opening and closing lateral movement of the beams **18** and **19** and are arranged so that a portion of the decreasing radius passes their cam followers **53** during the initial portion of the cycle. This allows the springs **106** and **107** to move the beams laterally toward each other for gripping of the blanks. While this is occurring dwell portions on the cams **78** and **98** pass by their associated followers **82** and **99**. respectively. The cams **54** are provided with dwell portions following this portion of decreasing radius which extend through an angle sufficient to retain the beams in their closed position until they have been raised, transferred longitudinally and lowered by the cams **78** and **98**.

As soon as the closing or gripping phase of the cycle is completed a lift portion on the cams 78 passes by the associated followers 82 to raise the beams 18 and 19. At the completion of this operation the dwell portion on the cams 78 passes under the followers 82 and a lift portion on the cam 98 begins to pass by its follower 99. This causes longitudinal movement of the beams 18 and 19 to the left as viewed in FIGURE 2.

As soon as this transverse movement is completed a dwell portion on the cam 98 commences to pass under its follower 99 and a portion of decreasing radius on the cams 78 commences to pass under its cam followers 82. Consequently, the beams 18 and 19 are lowered by the spring to position the blanks in the subsequent die stations. At the completion of the lowering operation a dwell portion on the cams 78 again passes under the followers 82 and a lift portion on the cams 54 commences to pass by the followers 53. This causes a lateral opening movement of the beams 18 and 19 so that the blanks are released. At the completion of the opening movement a dwell portion on the cams 54 commences to pass by the followers 53 while a portion of reducing radius on the cam 98 passes by the follower 99. When this occurs the spring 111 causes longitudinal movement of the beams 18 and 19 back to their original position and completes a cycle of operation. During such cycle each of the cams rotate through one complete revolution.

By separating the drives so that separate drives produce each of the three movements required by the beams 18 and 19 higher operating speeds are possible, since the mass that must be accelerated and decelerated during each phase of the operation is minimized. For example, the drives 76, 77 and 100 are not operated while the drives 46 and 47 are functioning. Similarly, the drives 76 and 77 operate while the drives 46, 47 and 100 are inoperative and finally the drive 100 operates while the drives 46, 47, 76 and 77 are inoperative. If, on the other hand, the drives were arranged so that a single drive provided two or more of the movements heavier drive mechanisms would be required since larger masses would have to be accelerated and decelerated at a given time. Also, the use of rectilinear transfer of movement permits the arrangement of the machine so that wasted motion is virtually eliminated, since the stroke or distance of movement in any given direction can be arranged to be substantially the minimum required amount of movement in each direction.

The ejection of the blank from the tools and dies on the die breast and on the ram is accomplished by a structure best illustrated in FIGURES 7 and 8. Ejector pins 116 extend through the machine frame at each die station requiring ejection. Each pin is provided with an associated operator arm 117 pivoted at 118 on the machine frame and an associated operating cam 119 mounted on a camshaft 121. Reciprocation or oscillating movement of the camshaft 121 is accomplished by a linkage including an arm 122 mounted on the camshaft, a pull rod 123 connected between the arm 122 and a follower arm 124. The follower arm supports a cam follower 126 which engages the cam 12 on the main crankshaft of the machine. The cam 12 and the cams 119 are arranged so that ejector pins 116 are operated to raise the blanks partially out of the dies in the die breast as the ram moves from its bottom dead center position back on its top dead center position.

Each of the operator arms 117 is provided with an extension 117*a* pivotally connected to a pneumatic cylinder 117*b*. The cylinders 117*b* operate to delay the dropping of the associated ejector pins 116 until the blanks are gripped by the transfer. The cam 12 is shaped to raise the ejector pins 116 during the upstroke of the ram and then return the linkage to its initial position before the ram reaches its top dead center position. However, when the ejector pins are raised the cylinders 117*b* are pressurized to hold the pins 116 in their raised position while the transfer beams move in for gripping. A control switch (not shown) is operated to exhaust the cylinders 117*b* when the beams 18 and 19 move upward. This allows the ejector pins 116 to drop down by the time the blanks are positioned in the subsequent dies.

FIGURE 8 discloses the basic arrangement for the drive of the ejectors carried by the ram 127. Ejector pins 128 are located in the ram at each die station requiring ejection to insure that the blanks do not remain on the tools carried by the ram 127 as the ram retracts from its forward dead center position. Associated with each ejector pin 128 is a follower arm 129 pivoted at 131 on the ram 127. The follower arm 129 is provided with a cam follower 132 engaging an associated cam 133 on a camshaft 134.

The camshaft is oscillated by a linkage including an arm 136 mounted thereon and connected to a link 137 which is in turn pivoted at 138 to the main pitman 139 of the machine. The pitman 139 is connected to an eccentric portion of the main crankshaft 141 and the ram is guided in the machine frame for vertical movement. Consequently, the pitman 139 oscillates around the axis 142 of its pivotal connection to the ram as the crankshaft 141 rotates. This oscillation is indicated by the arrow 143. The rate of oscillation of the pitman 139 is greatest with respect to ram movement as the ram passes through its dead center position.

The various elements are proportioned so that this oscillation of the pitman through the connection of the link 137 causes oscillating movement of the camshaft 134. The cams 133 supported by the camshaft are shaped to produce the timed movement of the follower arm 129 and in turn the ejector pins 128.

FIGURES 9 and 10 illustrate the feed mechanism for controlling the movement and feed of blanks into the machine. When the machine is used for hot forging heated blanks are supplied to the machine from a furnace and are guided into the machine along an open guide consisting of four rods 151. The lower ends of these rods are mounted on a fixed plate 152 having an aperture 153 therethrough. When the elements are in the position illustrated the aperture 153 is aligned with an opening 154 in a reciprocating gate member 156 and a blank 157 is free to drop through the two openings into the illustrated position in which it rests on a fixed plate 158. The gate member 156 provides a wall 159 to the left side of the blank 157 and is mounted for reciprocation between the full line position of FIGURE 10 and the phantom line position.

A pneumatic spring 161 resilinetly urges the gate 156 toward the phantom line position. A pair of horns 162 are mounted on the transfer beams 18 and 19 and are provided with adjustable bolts 163 engageable with a flat end face 164 on the gate member 156.

As the transfer beams 18 and 19 move longitudinally to their intial position the bolts 163 on the horns 162 push the gate member 156 against the action of the spring 161 to the full line position. In this position the openings 153 and 154 are aligned and a blank 157 drops down as illustrated. During the first portion of transfer movement the beams 18 and 19 move toward each other to the position illustrated in FIGURE 9 in which the horns 162 assist in confiningthe bank. However, the upper end of the blank extends through the opening 154 so it cannot tip over or fall.

As the beams are raised during the second phase of transfer operation the gate member 156 remains stationary and the adjusting bolts 163 merely ride up along the surface 164. However, as soon as the beams 18 and 19 move longitudinally in the transferring direction in the third phase of transfer operation the horns 162 move to the right, as viewed in FIGURE 10, allowing the spring 161 to carry the gate member 156 to the phantom line position. This causes the blank 157 to move to the position 157*a* over an opening 166 in the plate 158. The blank then drops down and rests on a pair of rods **167**. This moves the upper end of the blank clear of the walls of the opening **154** and permits return movement of the gate member **156** while the blank remains in the position **157***a*. At the completion of the longitudinal movement the next portion of transfer operation causes separation of the beams **18** and **19** and moves the horns **162** clear of the blank at **157***a*.

When the gate member **156** moves from the full line position of FIGURE 10 its upper surface **168** moves under the opening **153** and blocks remaining blanks so that a blank cannot move down until the feeding mechanism is in condition to receive a single blank.

The rods **167** are mounted for longitudinal movement under the base plate **158** and are connected for operation by an actuator **169**. In normal operation the actuator **169** retains the rods in the illustrated position so that a blank remains in the position **157***a* until its is gripped by the first pair of gripper fingers **20***a* carried by the beams **18** and **19** for transfer to the first die station. In the event that the operator sees that the blank located at **157***a* is improperly heated or is, for any other reason, unsuitable for forging operations he operates the actuator **169** to move the rods **167** clear of the opening **166** and the blank drops down along a reject chute **172**. Because the feed aparatus is operated by the transfer mechanism proper timing is assured and it is not necessary to utilize a separate operating means.

One preferred timing cycle for the machine is illustrated in FIGURE 11. This diagram represents one complete machine cycle during which the transfer cams rotate through three hundred and sixty degrees. In the illustrated timing diagram the cycle time is three seconds and the machine operates with twenty cycles a minute. During the first portion of the machine cycle the transfer beams **18** and **19** are moved toward each other as represented by the line **176**. This occurs during about the first $\frac{4}{10}$ths of a second of a cycle. As soon as the closing operation is completed the lifting operation is commenced as illustrated by the line **177**. As soon as the lifting operation is completed the longitudinal movement of the transfer transverse of the machine occurs as indicated by the line **178**. During this phase of operation the blanks are carried transversely along the die breast to a position above the subsequent die station. At the completion of the transverse movement the beams are lowered as indicated by the line **179** and the blanks are positioned in the subsequent die stations. The transfer beams **18** and **19** are then moved laterally apart as indicated by the line **181** to release the blanks and move the transfer clear of the die stations. Because there is a time lag in the operation of the clutch and brake mechanism an actuating switch is operated at the point **182** to initiate the release of the brake and engagement of the clutch so that the ram starts its downward travel by the time the transfer beams **18** and **19** are fully open. The sensing device for actuating the brake and clutch mechanism can be of any suitable type, such as a microswitch, operable in response to movement of one of the arms **48**. Such a switch is illustrated schematically at **183** in FIGURE 2.

After the transfer beams have moved apart to their open position two actions occur simultaneously. The ram **127** commences its downward movement as indicated by the line **184** and the transfer beams commence their longitudinal movement back to their initial position as indicated by the line **186**. In the illustrated timing diagram the entire ram cycle occurs in less than one second simultaneously with the movement of the transfer beams back to their initial position. Both the ram and transfer beams complete this phase of operation by the end of the three seconds of a complete cycle.

In some instances it may be desirable to initiate ram movement while the transfer is opening and commence the closing movement before the ram reaches its top dead center position. It is possible to overlap some of the functions in this manner if desired so long as the various operations are performed in such a manner that interferences are not produced.

Although a preferred embodiment of this invention is illustrated, it is to be understood that various modifications and rearrangements of parts may be resorted to without departing from the scope of the invention as defined in the following claims.

What is claimed is:

1. A transfer for forging machines having a plurality of die stations comprising a beam assembly including a pair of substantially parallel beams extending past said die stations each supporting gripper means adapted to grip blanks for transfer between said die stations, said beams being supported for operation through a cycle including movement in three directions, each direction of movement being substantially perpendicular to the other two directions of movement, and three separate drives operable in timed relationship to move said beams with the movement produced by each drive being substantially unaffected by the operation of the other drives, each drive being operable to move said beams in one of said directions.

2. A transfer as set forth in claim **1** wherein one of said directions of movement is lengthwise of said beams and the other two are lateral movements, said drives producing said lateral movements being connected to said beams adjacent to both ends thereof and being arranged to maintain said beams parallel while they are moved.

3. A transfer as set forth in claim **2** wherein the drive producing said lengthwise movement is connected to said beams only at one end thereof.

4. A transfer as set forth in claim **1** wherein all of said drives are separately driven by a single power source.

5. A transfer as set forth in claim **4** wherein each drive includes a spring and a cam, each spring urging its associated drive toward one position and each cam operating to positively move its associated drive to another position, said drive being arranged so that the gripping of blanks occurs in response to forces produced by said springs.

6. A transfer as set forth in claim **1** wherein only one drive operates at any given time in said cycle.

7. A transfer as set forth in claim **1** wherein during each cycle said beams first move laterally toward each other, then move normal to the die breast in a direction away therefrom, then move transversely with respect to the die breast in a forward direction, then move normal to and toward the die breast, then move laterally apart, and then move transversely in a return direction back to their initial position.

8. A transfer as set forth in claim **7** wherein said movement normal to and toward the die breast is in response to the operation of spring means.

9. A transfer as set forth in claim **1** wherein feed means are provided to supply workpieces to said machine, and said feed means are operated in response to movement of said beam assembly and supply a single blank for transfer during each of said cycles.

10. A transfer as set forth in claim **9** wherein said feed means includes a gate movable between first and second positions, said gate when in said first position permitting feeding of a single blank and blocking subsequent blanks when in positions other than said first position, movement of said gate from said first to said second position moving a single blank to a position for further transfer, resilient means urging said gate toward said second position, said beam assembly including means operable to move said gate toward said first position.

11. A transfer as set forth in claim **10** wherein holding means are provided to receive said single blank when said gate moves to said second position, said gripping means operating to transfer said single blank from said holding means to one of said die stations.

12. A transfer as set forth in claim **11** wherein said holding means includes a release mechanism which may be operated to remove a blank therefrom.

13. A forging machine comprising a die breast, a ram reciprocable relative to said breast, an intermittent ram drive operable when activated to drive said ram through a single cycle, tools and dies on said ram and breast cooperating to provide a plurality of die stations for progressively working a blank, a transfer including a pair of substantially parallel beams extending past said die stations, gripper means on said beams operable to progressively transfer blanks to each of said die stations, and three separate drive means each operable to move said beams in a direction substantially perpendicular to the direction of movement of the other of said drive means, and control means operable to activate said ram drive after said transfer moves a blank to a subsequent die station.

14. A forging machine comprising a die breast, a ram reciprocable toward and away from said breast, tools and dies on said ram and breast cooperating to provide a plurality of die stations for progressively forming blanks, a pair of substantially parallel beams extending across said breast, said beams being supported for rectilinear motion including sequentially closing motion for gripping blanks, removal motion for moving blanks clear of the dies, forward transverse motion for moving blanks to a subsequent die station, inserting motion for positioning blanks in said subsequent dies, opening motion to release blanks, and return transverse motion, similar first drive means connected to each end of said beams providing said removal and insertion motion, similar second drive means connected to each end of said beams providing said opening and closing motions, and third drive means connected to said beams to provide said forward and return transverse motions, the movement produced by each drive means being substantially unaffected by the movement produced by the other drive means.

15. A forging machine as set forth in claim **14** wherein said ram is intermittently driven, and control means actuate the ram drive during the opening movement of said beams.

16. A forging machine as set forth in claim **14** wherein ejector means are provided to eject blanks from said tools and dies, and a single power source powers said ram and said ejector means.

17. A transfer as set forth in claim **1** wherein two of said drives are connected to said beams through slide bearings arranged so that the beams are retained substantially parallel at all times.

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