United States Patent

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[54] **HORIZONTAL HIGH-SPEED TRANSFER**
7 Claims, 6 Drawing Figs.

[52] **U.S. Cl.** **214/1**
[51] **Int. Cl.** **B65g 25/04**
[50] **Field of Search** ..... 214/1 B

[56] **References Cited**

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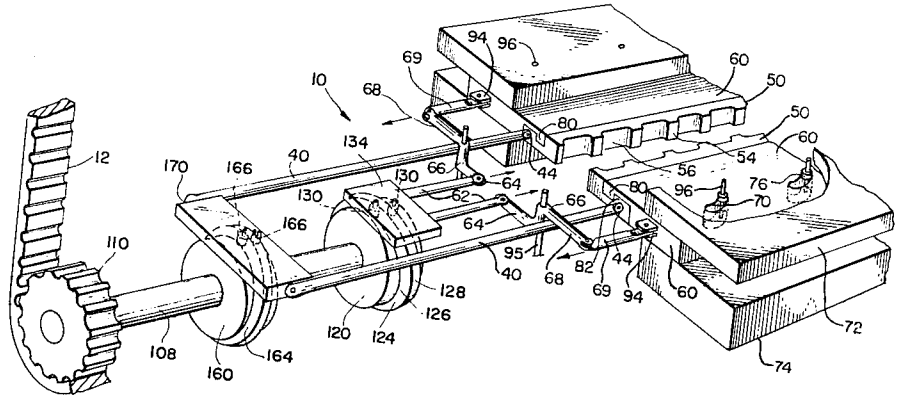
ABSTRACT: High-speed transfer apparatus for presses has spaced carrier bars with inward article receiving configurations. The carrier bars are mounted on carrier supports for longitudinal movement therewith and for relative transverse movement with respect thereto. The carrier bars are positively connected to the cam bars for lateral in and out movement therewith and for relative sliding. The carrier supports and cam bars are independently reciprocated in phase displaced relationship so the carrier bar moves forward after the cam bar has moved inward, and so the cam bar draws the carrier outward before the carrier is returned to its first position. The carrier and cam bar are reciprocated by separate rotating cams and followers. A cam flange extends radially outward from a cylindrical body and followers are mounted on opposite sides of the flange for continuous uniform direction rotation of the followers as the cam rotates, and the followers move slides which are connected to the cam bar and carrier bar.



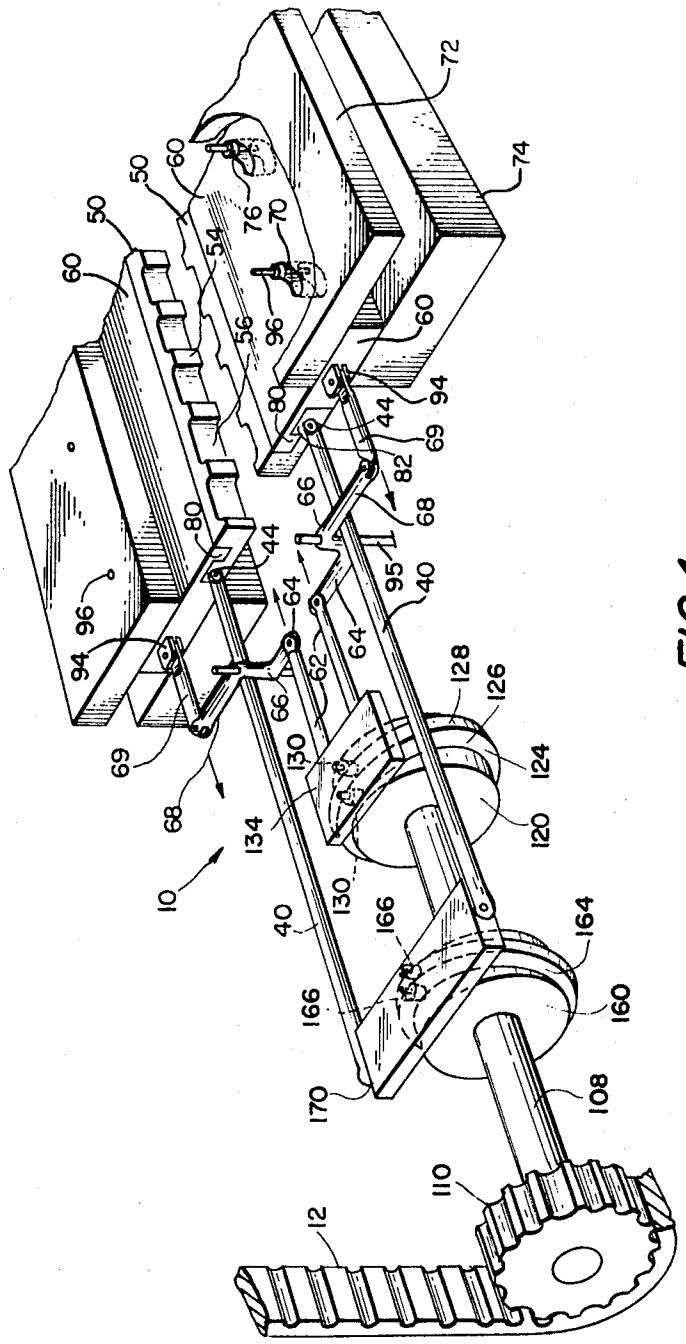


FIG. 1

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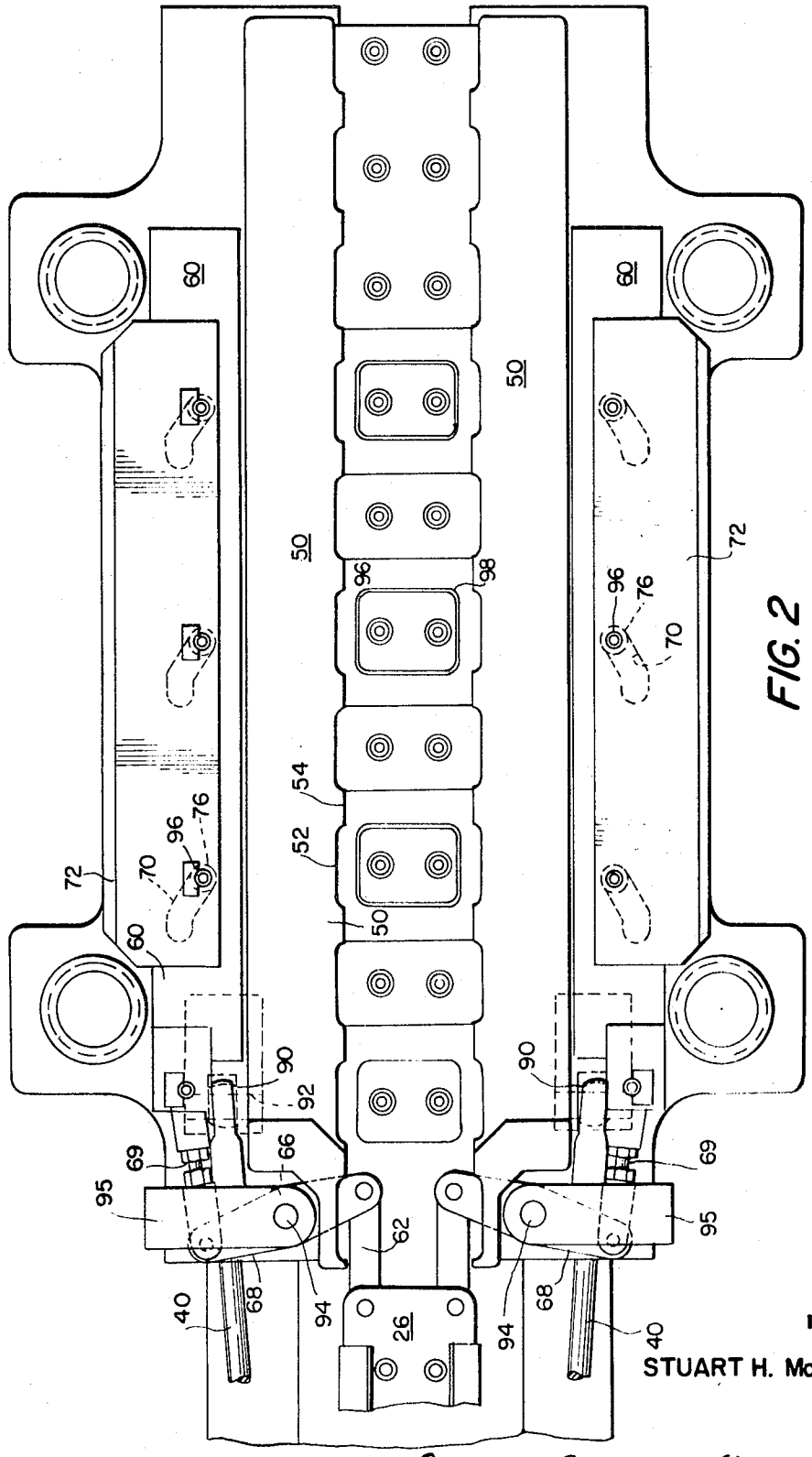

FIG. 2

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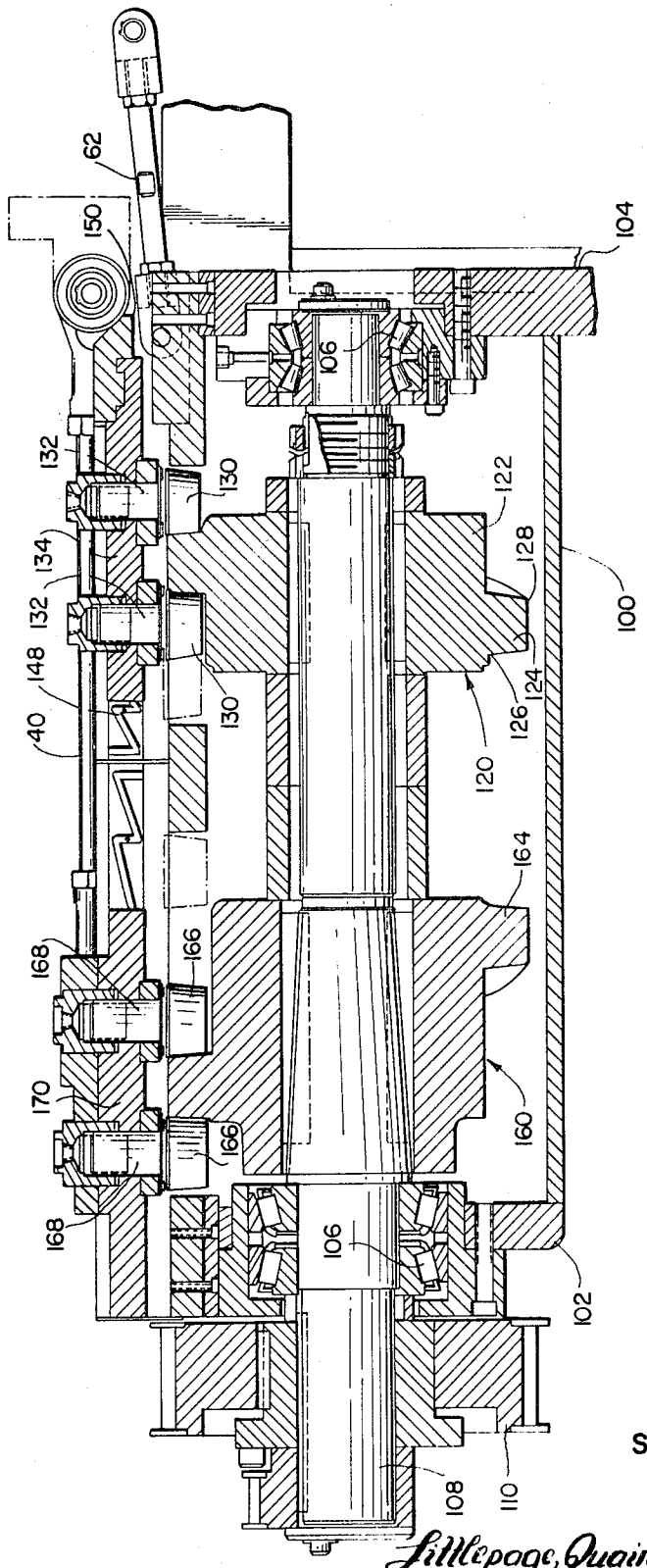

FIG. 3

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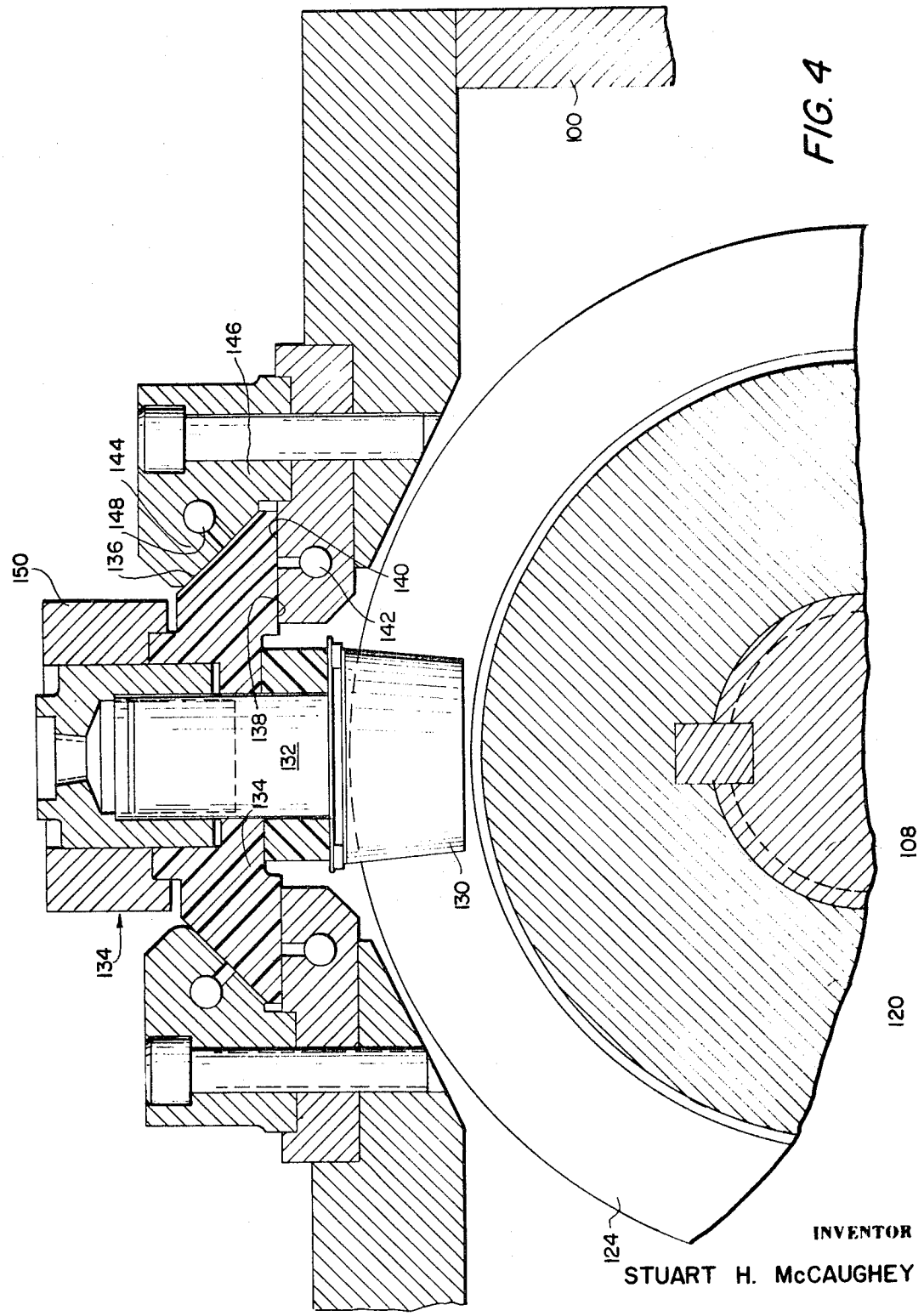

FIG. 4

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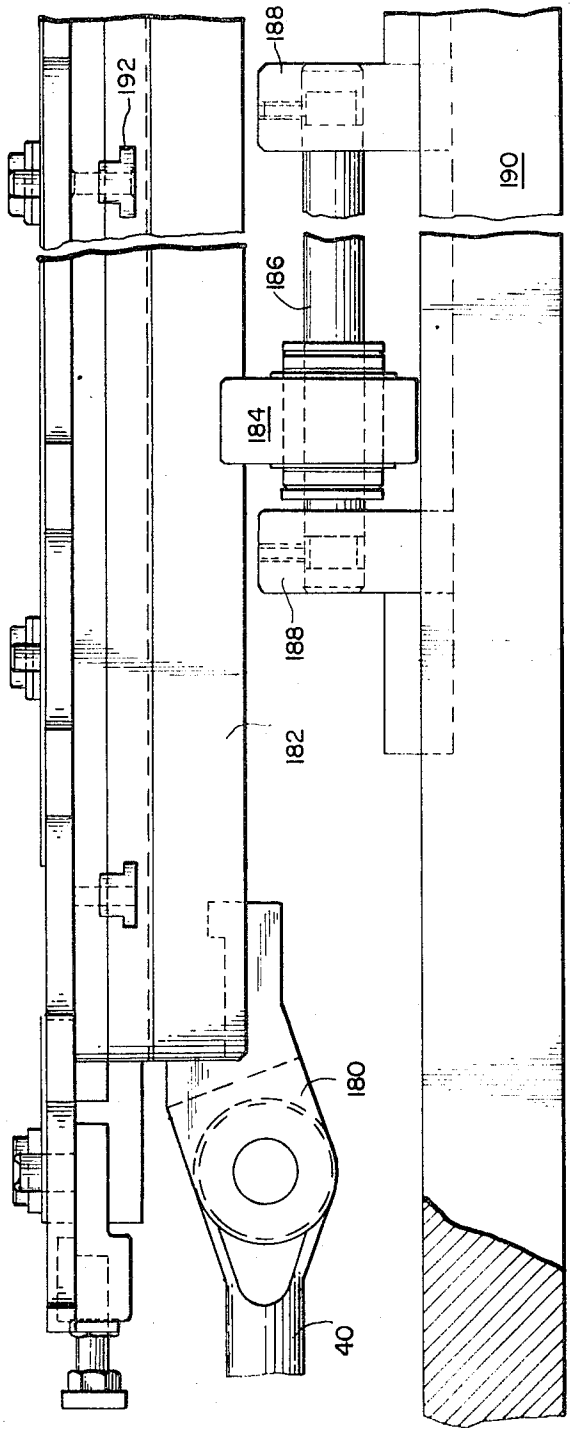

FIG. 5.

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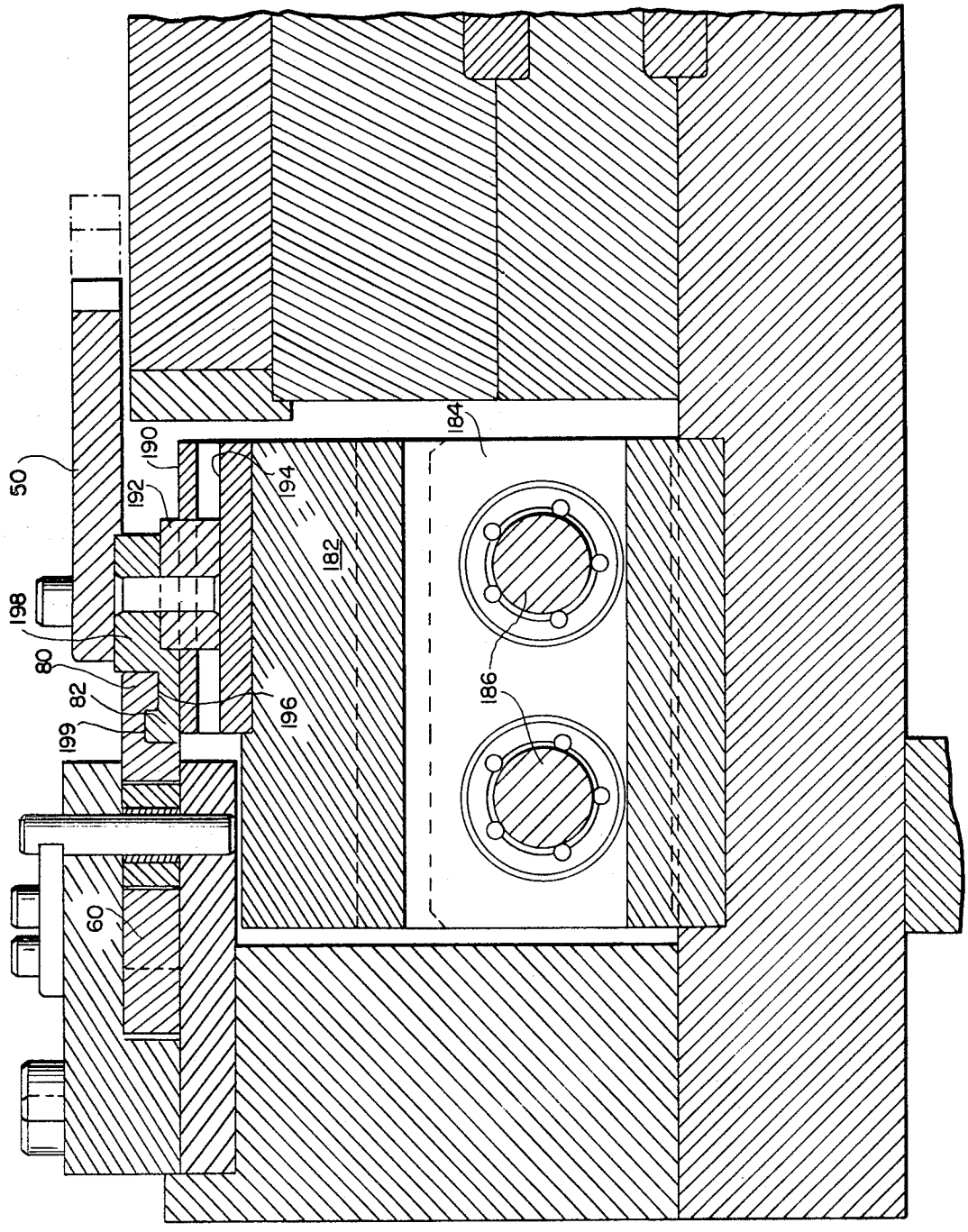

FIG. 6

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HORIZONTAL HIGH-SPEED TRANSFER

BACKGROUND OF THE INVENTION

This application is a continuation-in-part of U.S. Pat. application Ser. No. 713,830, filed on Mar. 18, 1968, row Pat. No. 3,528,575 by Stuart H. McCaughey for Feed and Transfer Systems.

Very high-speed press operations are made possible by new tool materials and press designs. One area which has limited the speed of press operations is the transfer apparatus which is used to feed articles from station to station in presses. Article feed or transfer apparatus has heretofore employed springs which required excessive operational times to move a part from one position to another. During the rapid accelerations while being transfered between work stations, workpieces which are not well engaged and held tend to float and misalign, jamming the machinery, or causing high-rejection rates, and necessitating high percentages of inspection and sampling. Forces which cause floating and misalignment increase geometrically with increasing cyclic speeds.

Movements must be very accurate in all transfers. In high-speed transfers, the accuracy of the transfer movements becomes critical. Play or backlash in transfer apparatus causes many problems which cannot be tolerated in high-speed equipment. Because of the increased accelerations, many conditions which are completely workable at low speeds, become destructive at high speeds. For example, the periodic reversing of direction of a cam follower roller may be tolerated at low-cyclic speeds. When the follower is cycled back and forth at high speeds, velocities of the roller and cam become high, and braking of the roller against the cam face becomes a serious problem upon each reversal of direction.

SUMMARY OF THE INVENTION

The high-speed article feed or transfer apparatus described herein is intended to overcome problems associated with high-speed transfer operations. The present apparatus is capable of operation at 350 cycles per minute and beyond. Each interrelated movement is produced by positively interlocked elements which permit relative motion only in the intended directions.

Timing belts are employed to drive the transfer apparatus directly from a rotating shaft which drives the press. A timing belt drives a gear pulley which is attached to a cam drive shaft. Two cylindrical cams are keyed on the drive shaft with the cams thereon in phased displaced relationship. In a preferred form, the cams are constructed with radially extended cam flanges which are curved to create the camming or reciprocal motion. Cam follower rollers are positioned on both sides of the cam flange so that the rollers continually rotate in a uniform direction. There is no braking, stopping and reversing direction of the cam follower rollers. The source of wear and backlash is thus eliminated.

The cam flange is preferably constructed with a tapering cross section so that its widest dimension is at its base and its smallest dimension is at its axially outward extremity. Follower rollers are tapered so that their smallest dimension is nearest the cam drive shaft. Where the cam flange's linear speed is least, it contacts the smallest circle of the follower roller. Where the cam flange's linear speed is greatest, it contacts the largest circle on the follower. Angular speeds of the follower are constant notwithstanding that the linear speed of the cam and follower increase incrementally with the increased distance from the center of the cam and drive shaft. Thus, there is no frictional cam drive shaft follower interface, and no backlash is developed.

Slides which support the cam follower axle ride on surfaces which are lubricated by zigzag lubricating channels. Upper surfaces of the slides are sloped to match the sloping retainer surfaces, which hold the slides inward toward the drive shaft.

The cam and slide farther from the drive pulley control the forward and rearward motions of the grooved cam bars which

move the carriers in and out. The cam and slide nearer the drive pulley reciprocate the carrier support and carrier bars in which workpiece engaging fingers or grooves are formed. Since the latter apparatus is the heavier of the reciprocating parts, and since it has the longest cyclic movements, acceleration forces are greater than in other parts of the transfer. Consequently, the carrier support and slide connections for the drive rod are aligned as closely as is convenient. Angular movements of the drive rods interconnecting the carrier support and slide are kept to a minimum.

The cam and slide which are further away from the drive pulley are similar to the before-described cam and slide. Connecting rods extend forward from the latter slide and connect to the lower flanges of two cranks with parallel vertical axles. Outer ends of the upper flanges of the cranks are connected to cam bars. The cam bars drive the parallel carrier bars in and out between article engaging and disengaging positions before the carrier bars are advanced or are withdrawn. The cam bars are mounted between upper and lower cam slides. In a preferred form of the invention the cam bars have apertures which are angularly oriented with respect to longitudinal directions of the bars. Sleeve bearing mounted wheels are placed within the apertures for rotating on axles mounted between the slide plates. As the cam bars are reciprocated longitudinally, the slope of the apertures causes the cam bars to be translated at angles to the longitudinal directions.

The carrier bars are attached to the cam bars to permit free relative sliding movement therebetween in longitudinal directions of the bars. The interconnections between the bars prevent relative transverse movement. Consequently, the carrier bars undergo the transverse component of the angular movement of the cam bars, while the cam bars slide longitudinally with respect to the carrier bars. The carrier bars move longitudinally with the cam and slide which are closest the drive pulley and move in and out according to movements of the other cam and slide which are communicated through the cam bars.

The objects of the invention may be carried out with several forms of camming means between the fixed frame or slide and the movable camming bar. For example, cam follower axles might be mounted in the cam bars and angular apertures might be cut in the cam slides.

For accurate longitudinal step by step advancement of the articles and for maintaining the desired connection between the carrier bars and the cam bars, the present invention provides a reciprocating support on which the cam bars are mounted. In a preferred form of the invention, parallel shafts are mounted on the transfer or press frame. The shafts are mounted at their ends to the frame of the transfer or press. Antifriction ball bearing slides surround portions of the shafts move back and forth thereon. Carrier supports are mounted on the antifriction slides, which, with the shafts, insure pure forward and rearward reciprocation of the supports. Upper surfaces of the supports are bearing surfaces for the carrier bars. The upper surfaces of the supports are configured for cooperating with the carrier bars to prevent forward and rearward movement between the carrier bars and the supports but to permit free lateral or transverse movement of the carrier bars.

One object of the invention is the provision of a high-speed horizontal transfer apparatus with positively controlled interrelated movements between elements.

Another object of this invention is the provision of horizontally movable transfer carriers and interconnected cam bars.

Another object of the invention is the provision of flanged cams with double tapered roller slide interconnections.

These and other objects of the invention will be apparent from the disclosure which is found in the foregoing and detailed specification portions as well as in the claims and in the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic detail of interrelated elements of a high-speed press transfer apparatus.

FIG. 2 is a plan view of the transfer apparatus particularly showing the carrier bar and the cam bar.

FIG. 3 is a cross-sectional elevation of the rotating to reciprocating drive apparatus showing the tapered radial cam flange and double tapered follower rollers.

FIG. 4 is a cross-sectional end elevation of the radial flange cam and follower.

FIG. 5 is a side elevational detail of the carrier bar support.

FIG. 6 is a cross-sectional elevation detail of the carrier bar, carrier support and cam bar.

DETAILED DESCRIPTION OF THE DRAWINGS

Transfer apparatus is generally indicated by numeral **10** in FIG. 1. A timing belt **12** turns a gear **110** in a direct relation to cyclic operations of a press. Preferably, timing belt **12** is connected to a press drive shaft which, for example, may extend outward from an upper portion of a press. Pulley **110** is keyed to transfer drive shaft **108**. Also keyed to the drive shaft is a first cylindrical cam body **120** which has a cam flange **128** radially extending therefrom. Cam flange **128** forms a smooth curve with portions of the cam positionally varying with respect to an axial direction of drive shaft **108**. In a preferred form of the cam, thickness at root **126** is greater than thickness at radial outward extremity **128**. Cam **120** reciprocates slide **134** by the action of two wheels **130** which are mounted on either side of the cam flange **128** and which are connected with axles to slide **134**. A second cylindrical body **160** supports a radially extending cam flange **164** which drives follower roller **166**. The cam follower rollers are mounted on axles **168** which are mounted in slide **170** and which extend downward therefrom on opposite sides of cam flange **164**. Rods **40** have first ends connected to pins which extend outward from opposite sides of slide **170**. Forward ends of rods **40** are connected through clevises **44** to carriers **50** which are schematically represented for clarity as single elements. Carrier bars **50** have recesses **52** and fingers **54** which grip articles to be transferred step by step between die stations in a press. Rods **40**, slide **170** and cam **160** reciprocate the carriers forward and rearward. Inward and outward motion is imparted to carrier bars **50** by cam bars **60**. The latter are driven back and forth through linkage which is moved by slide **134** and cam **120**. Rods **62** are connected to a forward edge of slide **154**. Forward ends of the rods are connected to lower flanges **64** of cranks **66**. Upper flanges **68** of the cranks are connected through rod **69** to the cam bars **60**.

Each cam bar has several cam apertures **70** which are disposed in the cam bar at an angle to a longitudinal direction of the cam bar. Upper and lower cam slides **72** and **74** hold axles on which cam follower wheels **76** are mounted. As the cam bars **60** are driven forward and rearward by the linkage, wheels **76** bear upon the cam apertures **70** causing the bars to translate angularly in a horizontal plane. As cam bars **60** translate, the transverse component of the translation is imparted to carriers **50**. Elongated hooked shaped interconnections **80** and **82** between the cam bar and carrier permit relative longitudinal sliding but prevent relative transverse motion of the bars. Therefore, carrier bar **50** undergoes the transverse component of the translation of cam bars **60**.

In FIG. 2 the carrier bar **50** and cam bar **60** are shown interconnected and partially exposed. Rod **40** is connected through a ball joint **90** to a pin **92** which is mounted in a support which reciprocates the carrier bar **50** longitudinally.

Rods **69** are connected between upper flanges **68** of cranks **66** and clevises **94**, which are mounted on ends of cam bars **60**. Cranks **66** rotate on vertical axles **95**.

Upper cam slides **72** hold vertical axles **96** upon which skate wheels **76** are mounted. Skate wheels **76** are disposed within cam apertures **70** in cam bars **60**. As shown in the drawing, the cam bars are in rearward or leftmost position. When the cam bars are moved forward, the angularly oriented walls of apertures **70** cause the cam bars to move inward. Since there are several apertures and skate wheels, the entire bars translate angularly in a forward and inward direction in a horizontal plane. As that happens, carrier bars **50** are pushed inward, so that the recesses **52** and teeth **54** engage articles **96** in the die stations **98**.

Rods **40** are then driven forward, pushing carrier bars **50** and articles engaged thereby forward to the next die stations. Preferably, that transfer action occurs as the upper die is being lifted by the press.

On the down stroke of the press, slid **26** moves forward, turning cranks **66**, and drawing rods **69** and cam bars **60** rearward. The action of skate wheels **76** and cam apertures **70** causes the cam bars to translate outwardly and rearwardly, drawing the carrier bars **50** outward, and disengaging the carrier from the articles which remain in the die stations. As soon as the carrier bars have been disengaged from the articles, rods **40** may be rearward, returning the carrier bars **50** to their original rearward positions.

Referring to FIG. 3, a cam base which is part of the fixed transfer frame is configured similar to well-known crankcases. The upper surface of the base or frame is a sliding surface with oil groove lubrication. Base **100** is sealed at both ends **102** and **104**, where tapered roller bearings support the shaft for rotation.

One end of drive shaft **108** mounts a gear-toothed pulley which is keyed to the drive shaft. A timing belt drives the pulley **110**.

The cylindrical body **122** of a first drive cam **120** is keyed to drive shaft **108** at a remote location thereon from the drive pulley. A cam flange **124** extends radially from body **122** and smoothly incrementally varies axial position around the circumference of the body. Cam flange **124** is tapered from a maximum cross-sectional dimension adjacent root **126** to a minimum cross-sectional dimension adjacent outer edge **128**. Cam follower rollers **130** are mounted on opposite sides of the cam flange. Rollers **130** are tapered complimentary to the cam flange taper. Parallel axles **132** extend upward from the cam followers and are mounted in a first slide **134**.

As shown in FIG. 4, upper surfaces **136** of the slide body are sloped, whereas lower surfaces **138** are flat. Lower surfaces **138** ride on sliding surfaces **140** which are lubricated by passageways **142**. The sloping upper surfaces are engaged by complimentary sloping surfaces **144** of retainers **146** which are lubricated by oil passages **148**. Rod **62** which drives the crank and cam bar is connected to a plate **150** secured at the forward end of slide **134**.

A second cam **160** is connected to the drive shaft near the drive pulley. The second cam, cam followers and slide are configured closely similar to the first cam, and the identification numbers are similar to identify the elements. One difference between cam **120** and cam **160** is that the latter has a greater cyclic travel. Cam flange **164** drive cam follower rollers **166**. The rollers are mounted on shaft **168** in slide **170**. Oil channels **142** and **148** serve sliding surfaces **140** and **144** as shown in FIG. 4. Slide **170** is connected to rod **40** which drives the carrier apparatus.

As shown in the detail of FIG. 5, rod **40** is connected to a clevis **180** which is mounted on slide support **182**. The slid support rests upon an antifriction bearing **184** which surrounds a portion of shaft **186**. Shaft **186** is mounted at ends thereof with mounts **188** which are anchored on the transfer or press frame **190**.

The slide support **182** is shown in a cross-sectional detail of FIG. 6. Shafts **186** support bearing **184** which surrounds portions of the shaft. The slide support **182** is fixed to the bearing so that support **182** moves forward and rearward or in and out of the drawing plane in pure reciprocation. Carrier bar **50** slides on an upper surface **190** of support **182**. A key **192** and a keyway **194** permit lateral movement of carrier bar **50** and support **182** but prevent relative longitudinal movement.

The downward hooked portion **80** of cam bar **60** fits within a groove **196** in carrier bar attachment portion **198**. The

hooklike portion 82 of the carrier bar section 198 fits in a similar groove 199 in the cam bar. Thus, the carrier bar 50 and cam bar 60 are permitted to slide longitudinally relative to each other, but the carrier bar and cam bar are firmly interconnected to move laterally together.

Although the invention has been described with reference to specific embodiments, it will be appreciated by those skilled in the art that other embodiments may be constructed without departing from the teachings of the invention. The scope of the invention is defined only in the following claims.

That which is claimed is:

1. Article transfer apparatus comprising:

a frame,

a cam slide having a horizontal sliding surface fixed to the frame,

an elongated cam bar mounted on the horizontal sliding surface of the slide for movement thereon,

first and second cam means, the first cam means comprising cam apertures angularly disposed with respect to an elongated direction of the cam bar, and the second cam means comprising cam followers positioned in the apertures and having axles extending outward therefrom, one of the cam means being fixed in the cam bar, and the other of the cam means being fixed in the frame,

an elongated carrier mounted on the frame parallel to the cam bar and connected to the cam bar for free relative sliding movement relative to the frame and for free longitudinal sliding movement relative to the cam bar and for lateral movement with the cam bar, the elongated carrier having article engaging means on one side thereof,

first reciprocating means connected to the cam bar for moving the cam bar forward and rearward in a longitudinal direction thereof, thereby causing angular translational movement of the cam bar by interaction of the first and second cam means,

second reciprocating means connected to the carrier for moving the carrier forward and rearward in a longitudinal direction thereof,

timing means connected to the first and second reciprocating means for operating the reciprocating means in phase-displaced relation, whereby the cam bar and carrier move longitudinally at different times.

2. The transfer apparatus of claim 1 wherein the first cam means apertures are disposed in the cam bar and wherein the second cam means followers comprise wheels disposed within the apertures and axles extending outward therefrom and fixed in the cam slide.

3. The transfer apparatus of claim 1 wherein the carrier has at a second side thereof opposite the article engaging surface an outward and upward extending elongated portion having a hooklike cross section, and wherein the cam bar has at a lateral side thereof adjacent the carrier an elongated portion having a complementary hooklike cross section which is interconnected with the portion of the carrier, permitting relative longitudinal sliding between the carrier and cam bar, and preventing relative lateral movement therebetween.

4. The transfer apparatus of claim 1 wherein the carrier mounting comprises elongated shafts mounted on the frame parallel to the carrier and beneath the carrier, and antifriction bearings surrounding portions of the shafts, a carrier support fixed to upper portions of the bearings, the carrier support having an upper sliding surface, elongated carrier bars mounted on the sliding surface, groove and lug interconnection means on the sliding surface and the carrier bar and the interconnection means being oriented transverse to an elongated direction thereof for permitting lateral movement of a carrier bar with respect to the support and for preventing relative longitudinal motion therebetween, and wherein a cam bar engaging means is formed on a side of the carrier bar opposite the article engaging means, and wherein the second reciprocating means is connected to the carrier support for moving the support forward and rearward on the shafts and for driving the carrier bar forward and rearward with the carrier support.

5. The transfer apparatus of claim 1 wherein the timing means comprises a drive shaft mounted for rotation on the frame, and means for rotating the drive shaft, and wherein the first reciprocating means comprises a first cylindrical body keyed to the drive shaft and having a cam flange extending radially therefrom at a smoothly varying axial position with respect to the drive shaft, cam follower rollers mounted on opposite sides of the cam flange, and axles extending upward from the follower rollers, a slide connected to the axles and having a lower surface configured for sliding on the frame and a linkage interconnecting the slide and the cam bar, and wherein the second reciprocating means comprises a second cylindrical body keyed to the drive shaft and a second radially extending cam flange having smoothly varying axial position mounted on the second body, second cam follower rollers mounted on opposite sides of the second cam flange, axles extending upward from the follower rollers, and a second slide rigidly supporting the axles, the second slide having a lower surface configured for sliding along the frame in a movement controlled by the second cam flange and second follower rollers, and second linkage means interconnecting the second slide carrier.

6. The transfer apparatus of claim 5 wherein the first linkage comprises a first connecting rod extending from the first slide toward the cam bar, a crank having a vertical axis and having a lower radial flange connected at an outer end thereof to a second end of the first rod, the crank having a second flange extending radially outward with an outer end connected to a first end of a second rod having a second end connected to the cam bar.

7. The transfer apparatus of claim 1 further comprising a second cam slide mounted on the frame parallel to the first cam slide, a second cam bar mounted on the second cam slide parallel to the first cam bar, third and fourth cam means interconnecting the frame and the second cam bar, a second carrier slidably mounted on the frame parallel to the second cam bar and connected thereto for lateral movement therewith, wherein the first and second carriers define an article receiving and treating space therebetween.

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