March 31, 1970 NAONORI TANIGUCHI 3,503,491

DEVICE FOR SERIALLY AND SYNCHRONOUSLY FEEDING WORKPIECES

Filed Aug. 21, 1967 4 Sheets-Sheet 1

Fig. 1

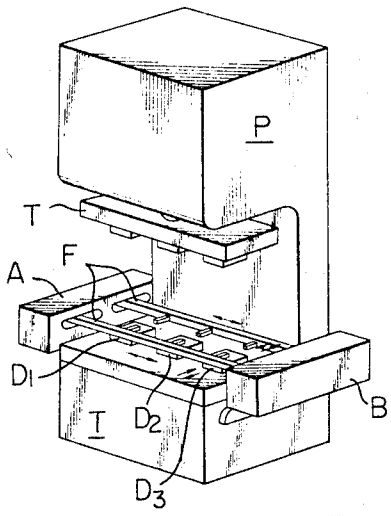


Fig. 3

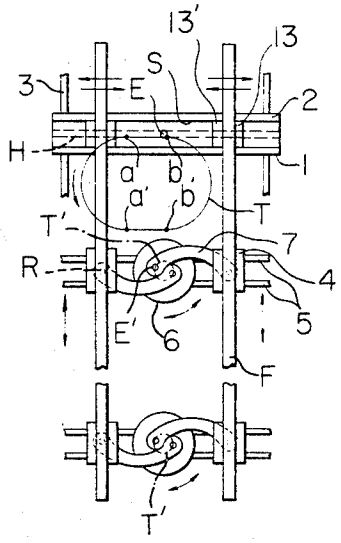
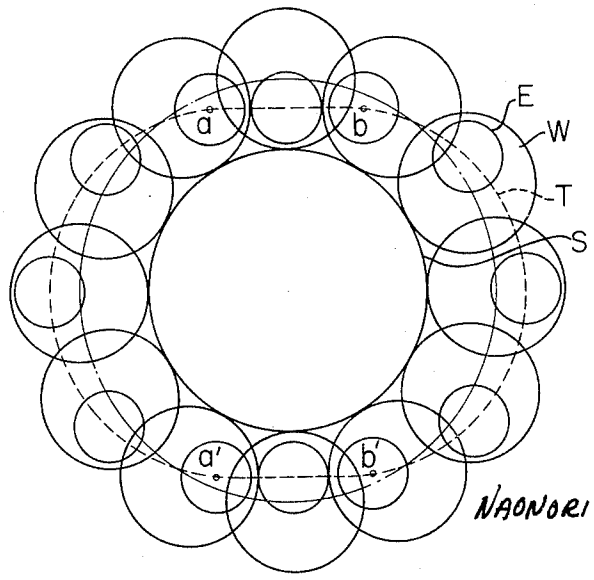


Fig. 2



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DEVICE FOR SERIALLY AND SYNCHRONOUSLY FEEDING WORKPIECES

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Fig. 4

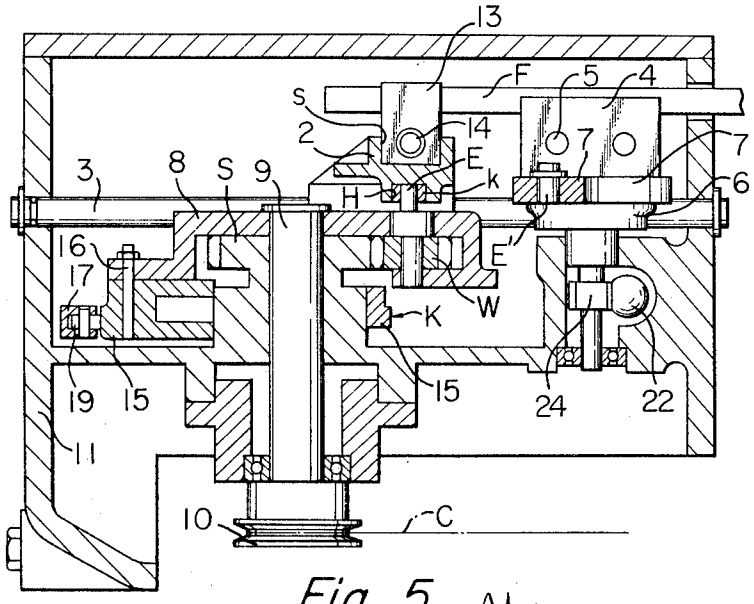
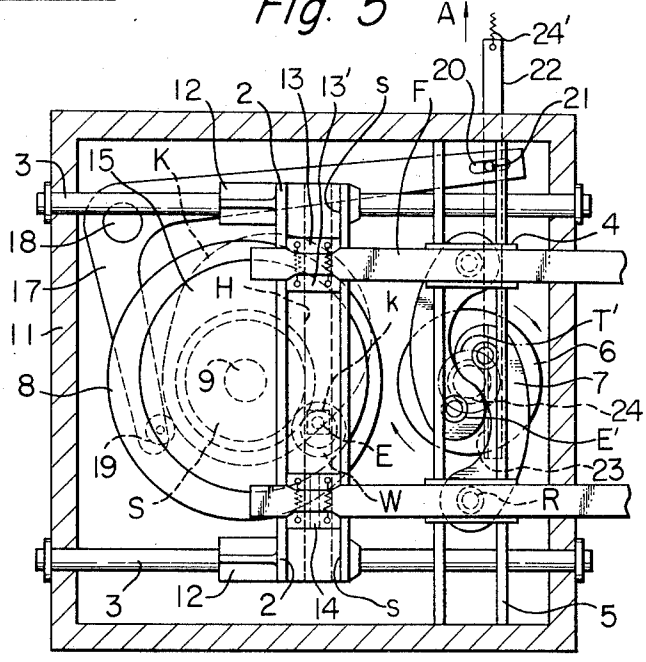


Fig. 5



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DEVICE FOR SERIALLY AND SYNCHRONOUSLY FEEDING WORKPIECES

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Fig. 6

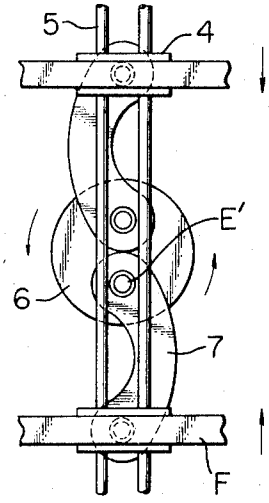


Fig. 7

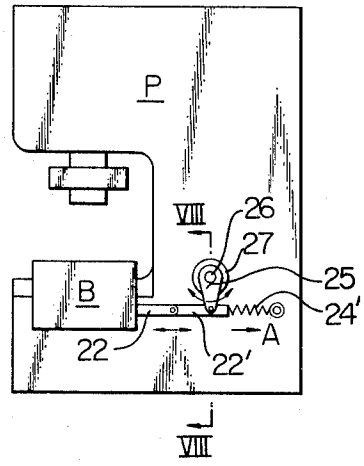
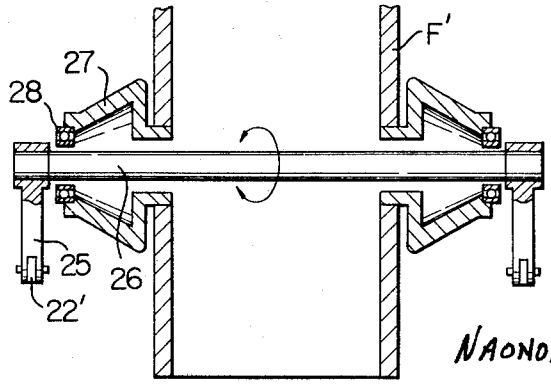


Fig. 8



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DEVICE FOR SERIALLY AND SYNCHRONOUSLY FEEDING WORKPIECES

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Fig. 9

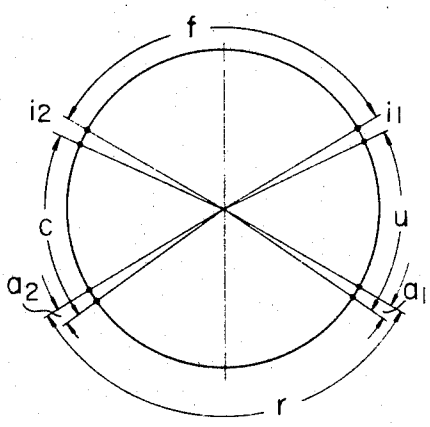
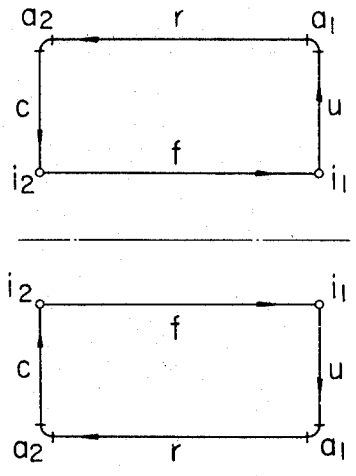


Fig. 10



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United States Patent Office 3,503,491
Patented Mar. 31, 1970

3,503,491

DEVICE FOR SERIALLY AND SYNCHRONOUSLY FEEDING WORKPIECES

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Int. Cl. B65g 25/04
U.S. Cl. 198—218 5 Claims

ABSTRACT OF THE DISCLOSURE

A device for serially and synchronously feeding pieces to be worked to succeeding working stations, respectively, for use with a working machine having a plurality of working stations equally spaced apart from each other in a straight line of feed of workpieces for successive working steps comprising a pair of parallel spaced feeding rods located on respective sides of the row of working stations, said rods being first laterally moved in parallel toward each other for simultaneously gripping the workpieces on each of the working stations, then longitudinally moved so as to position the workpieces on the succeeding working stations, respectively, thereafter laterally moved away in parallel from each other thereby leaving the workpieces on each of the working stations in registry therewith, and finally longitudinally moved back to their initial positions so as to repeat the cycle of the above movements in succession, the speed of each of the longitudinal and lateral movements of the feeding rods being reduced to the minimum at the start and the end of each of the movements thereby decreasing the acceleration and retardation of the moving parts of the device.

BACKGROUND OF THE INVENTION

The present invention relates to a device for serially and synchronously feeding pieces to be worked by a working machine such as a press or the like, and, more particularly, to a device for serially and synchronously feeding workpieces in a predetermined direction to succeeding working stations for successive working steps.

Heretofore, workpieces have been fed either manually or automatically as part of a continuous strip. With manual feeding the operators feeds the pieces to be worked one by one to the machine—for example, a press—each time the pressing operation is to be performed. However, manual feeding is very troublesome and time consuming and, therefore, is not suitable for a high speed press. With strip feeding a strip of metal or other material is fed intermittently to the press by feed rollers or gripper feed mechanism in timed relation to the working of the press. After having been worked, the pieces are separated from the strip. Strip feeding is suitable for high speed presses, but is limited to the working of pieces fed in the form of a continuous strip. With strip feeding it is impossible to serially feed separate working pieces to succeeding working stations.

SUMMARY OF THE INVENTION

The present invention avoids the aforementioned disadvantages and provides a novel and useful device for serially and synchronously and automatically feeding workpieces to succeeding working stations in a machine such as a transfer press.

Therefore, an object of the present invention is to provide a novel and useful device for use with a working machine such as a press for serially and synchronously feeding workpieces through a series of working stations.

Another object of the present invention is to provide a device of the type described above in which there is

minimal acceleration and retardation of each of the moving parts, so that the device can operate efficiently at high speed and the working life of the machine is increased.

A further object of the present invention is to provide a novel and useful device of the type described above in which a pair of spaced parallel feeding rods are utilized which are provided with a plurality of gripping arms extending therefrom toward the working stations for simultaneously and intermittently gripping and releasing the workpieces located in the working stations which are arranged at equally spaced positions in a straight line in the working machine which is adapted to perform successive steps. The pair of parallel feeding rods is shiftable toward each other so as to simultaneously grip the workpieces at each of the working stations, then, while they hold the workpieces, being movable to the positions where the suceeding working steps are to be carried out on workpieces. Said pair of parallel rods thereafter are shiftable away from each other thereby releasing the workpieces and leaving them in registry with the working stations where the succeeding working steps are to be carried out, and then are movable longitudinally back to their initial positions for the next cycle of operations. The feeding cycle is performed intermittently in timed relation to the operation of the working machine so said feeding and operating do not interfere with each other, said forward and backward longitudinal movement of the parallel feeding rods being effected by utilizing a planetary gear mechanism in which a planetary gear rolls around a stationary sun gear. Said planetary gear has an eccentric pin thereon which travels in a generally elliptical orbit having a pair of oppositely located parallel straight portions therein, the component of the movement of the eccentric pin on the planetary gear along the arcuate portions of said elliptical orbit projected to a line at right angle to said parallel straight portions of said elliptical orbit being utilized for forward and backward longitudinal movement of the feeding rods thereby reducing the acceleration and retardation of the longitudinal movement of the rods. The lateral shifting movement of the rods in parallel to and from each other is effected by utilizing two sets of correspondingly operated crank motions each obtained by a pair of eccentric pins located diametrically opposite to each other on a disc reciprocally rotated in a half circle in timed relation to the longitudinal movement of the feeding rods and a pair of connecting rods each connected rotatably at one end thereof to each of said eccentric pins and at the other end to each of sliders movable in the direction transverse to the length of the feeding rods and slidably engaged with each of the feeding rods so that the disc is rotated while the longitudinal movement of feeding rods is stopped. At the same time the connecting rods push the rods away from each other in parallel relation to each other or pull the rods toward each other in parallel to each other thereby reducing the acceleration and retardation of the lateral shifting movement of the parallel rods away from and toward each other because the arcuate motion of the eccentric pin is transformed into a straight line motion of the slider through the connecting rod.

The above and other objects and advantages of the present invention will be fully understood by reading the following description setting forth a preferred embodiment of the present invention in connection with the attached drawings illustrating the embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a general schematic perspective view showing the device for serially feeding workpieces in accordance with the present invention attached to a press.

FIG. 2 is a diagram showing the orbit obtained by the planetary gear mechanism used in the feeding mechanism of the present invention,

FIG. 3 is a schematic view showing the movement of the feeding rods of the feeding mechanism in accordance with the present invention,

FIG. 4 is a cross-sectional view showing the internal mechanism of the feeding device in the embodiment of the present invention,

FIG. 5 is a plan view as seen from above of the internal mechanism of FIG. 4 with the cover of the casing removed for clarity,

FIG. 6 is a fragmentary view showing the disc-connecting rod connection for varying the distance between the feeding rods shown in FIG. 5 when the feeding rods are part from each other,

FIG. 7 is a side elevation of the devices for actuating synchronously a pair of disc-connecting rod connections for varying the distance between the feeding rods located on each side of the press,

FIG. 8 is a cross-sectional view of the device shown in FIG. 7 along the line VIII—VIII in FIG. 7,

FIG. 9 is a diagram showing the relationship between the feeding, returning movement and lateral movement of the parallel feeding bars away from and toward each other with respect to the rotating angle of the main spindle of the press, and

FIG. 10 is a diagram showing the movement of the feeding rods as seen from above.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in FIG. 1, when the device for serially feeding workpieces in accordance with the present invention is applied to a press P, one rod of a pair of parallel feeding rods F is located on each side of a plurality of dies D_1, D_2, D_3—mounted on table T of the press in parallel thereto, said dies being spaced equally from each other in a straight line, each of said dies being adapted to perform a particular working step in a predetermined order. Each of said feeding rods is provided with a plurality of gripping arms attached thereto at a distance equal to the distance between the adjacent two dies and extending inwardly toward the line of dies and adapted to simultaneously grasp the workpieces located on the dies for feeding each of the workpieces to its respective succeeding die where the successive working step is to be carried out in timed relation to the working of the press so said feeding does not interfere with the pressing operation. Said pair of parallel feeding rods are moved toward each other so that grasping arms of each of the feeding rods is aligned with each of the dies so as to simultaneously grasp the workpieces located on the dies, the feeding rods thereafter being moved longitudinally of the rods a distance equal to the distance between the adjacent two dies while the workpieces are held by the grasping arm. Said parallel rods are then moved apart from each other thereby releasing the workpieces, leaving them in registry with their respective dies so that the workpieces can be worked by the press, said rods thereafter being moved longitudinally back to their initial positions. The above-mentioned cycle of the movements of the feeding rods is repeated so as to serially feed one or more workpieces simultaneously to the dies where successive working steps are to be carried out, in timed relationship to the working of the press. The velocity component of the longitudinal movement of the feeding rods along arcuate portions *aa'*, *b'b* of orbit T of an eccentric pin E (FIGS. 2 and 3) on a planetary gear W rolling around a stationary sun gear S is utilized so as to reduce the velocity at the start and the end of the travel, said velocity component being obtained by projecting the movement of eccentric pin E along arcuate portions *aa'*, *b'b* on the straight line at right angle with respect to the longitudinal axis of the elliptical orbit T along which said eccentric pin E travels. Said elliptical orbit T has two straight portions *ab*, *a'b'* parallel to the longitudinal axis of the orbit T when the ratio between the diameter of the sun gear S, the diameter of the planetary gear W and the eccentricity of the eccentric pin E with respect to the axis of the planetary gear W is selected to be substantially of 10:5:1. This ratio can be modified insofar as two parallel straight portions *ab*, *a'b'* are obtained in elliptical orbit T.

In order to longitudinally move feeding rods F, eccentric pin E on planetary gear W is pivotally connected to a slider *k* (FIGS. 4, 5) slidably engaged with slide way H at the lower side of slide guide **2** which in turn is guided by guide rods **3** so as to be movable in the direction of the length of feeding rods F. Said slide guide **2** is provided with slide way *s* in the direction transverse to the length of feeding rods F at the upper side thereof. Two sets of clamping members **13**, **13'** are slidably engaged in said slide way *s*. Each of said set of clamping members **13**, **13'** resiliently hold each of feeding rods F so that, when slide guide **2** moves longitudinally of feeding rods F, clamping members **13**, **13'** move feeding rods F together. However, in case failure to accidentally stop the longitudinal movement of feeding rods F occurs, clamping members **13**, **13'** may be disengaged from feeding rods F so as not to harm the feeding device of the present invention. It is evident that longitudinal movement of feeding rods F is achieved by the movement of eccentric pin E along the arcuate portions *aa'*, *b'b* through slide guide **2** which slidably carries slider *k* connected to pin E and clamping members **13**, **13'** resiliently hold feeding rods F, the acceleration, and retardation of said longitudinal movement of feeding rods being minimized by utilizing the velocity component of eccentric pin E along the arcuate portions *aa'*, *b'b* in orbit T projected to the line parallel to the length of feeding rods F.

The lateral movement of parallel feeding rods F away from and toward each other is given by the actuation of disc-connecting rod device (**4**, **6**, **7**) while said eccentric pin E on planetary gear W travels along said straight portions *ab*, *a'b'* of said ellipitcal orbit T so as to prevent the feeding rods from moving longitudinally during the lateral movement of the feeding rods. One end of each of the connecting rods **7** is pivotally journaled on each of a pair of eccentric pins E' diametrically oppositely located on a rotating disc **6** reciprocably rotated in half a circle so that said one end of each of the connecting rods **7** reciprocably travels in half a circular path T', while the other end of each of rods **7** is pivotally connected to a slider **4** slidably engaged with each of the feeding rods F and guided by means of guide rods **5** to move in the direction transverse to the feeding rod F so that said other end of the connecting rod **7** moves in a straight line transverse to the longitudinal direction of the feeding rods F. This disc-connecting rod device (**4**, **6**, **7**) provides the minimum velocity at the start and the end of the lateral movement of the parallel feeding rods F toward and away from each other.

The detailed construction of the preferred embodiment of the present invention will now be set forth referring to FIGS. 4–8.

In FIG. 4, planetary gear W is rotatably journaled on rotating member **8** fixedly mounted on shaft **9** which in turn carries on it a sprocket **10** driven through chain C by power source (not shown). Planetary gear W is adapted to roll around a stationary sun gear S integrally fixed to casing **11** and located coaxially with said shaft **9**. Eccentric pin E is fixedly mounted on planetary gear W, said pin E is rotatably engaged with rectangular or square slider *k* which slidably engages with slide way H provided at the under side of slide guide **2**. As shown in FIG. 5, slide guide **2** is provided with a pair of bases **12** adjacent to both ends of the base portion thereof. A pair of guide rods **3** are secured to casing **11** in the direction parallel to the length of feeding rods F. A hole is provided in each of said bases **12** in which is slidably engaged

each of said guide rods **3** so as to guide said slide guide **2** in the direction parallel to the longitudinal direction of feeding rods F. Said slide guide **2** is provided with a slide way *s* at the upper side thereof, in which two sets of pairs of clamping members **13, 13'** are slidably engaged, each pair of said pairs of clamping members **13, 13'** being slidably connected by means of shaft **14** and urged toward each other by means of spring so as to resiliently clamp feeding rods F so that each feeding rod F is moved longitudinally together with clamping members **13, 13'** when the latter are driven longitudinally feeding rod F. To this end each of the faces of members **13** and **13'** facing each other is provided with beveled surfaces at both ends which are engaged with complementarily formed beveled surfaces provided on the sides of feeding rod F. This arrangement allows the clamping members **13, 13'** to be disengaged from feeding rod F when accidental external force is applied to feeding rod F, so that no harm is caused to the feeding device when external failure occurs.

Sprocket **10** consists of two pieces provided with serrations on the mating surfaces thereof so that adjustment of the angular relationship between shaft **9** and the main spindle of the press may be effected by relatively rotating serrations of two pieces of sprocket **10** in order to set the proper timed relation between the pressing and feeding of the workpieces. Of course, the chain and sprocket drive above described can be replaced by any suitable gear drive.

Contour cam **15** is fixedly secured to rotating member **8** by means of bolt **16**. Cam surface K is formed on the outer periphery of said cam **15**. A bell crank **17** is pivotally mounted on shaft **18** secured to casing **11**, one end of one of the arms of said bell crank mounting rotatable roller **19** which is adapted to contact with said cam surface K. The other arm of said bell crank **17** is provided with an elongated hole **20**, in which a pin **21** fixed to rack rod **22** axially slidably fitted with casing **11** is slidably fitted, said rack rod **22** being oriented in the direction at right angle with respect to the longitudinal direction of feeding rod F. Said rack rod **22** is biased by means of resilient means such as spring or pneumatic means schematically designated by reference numeral **24'** in the direction shown by arrow A, so that said bell crank **17** is urged to rotate in the counterclockwise direction by the engagement of pin **21** and elongated hole **20** as shown in FIG. 5, thereby resiliently urging said roller **19** against cam surface K. Roller **19** follows the contour of cam surface K as cam **15** is rotated thereby swinging bell crank **17** in accordance with the contour of cam surface K. Rack rod **22** is provided with toothed rack portion **23** at the end portion thereof, which meshes with pinion **24** coaxially and integrally secured to disc **6**. When bell crank **17** is swung by the rotation of cam **15** so that rack rod **22** is moved axially, disc **6** is reciprocably rotated in half a circle by the engagement of toothed rack portion **23** with pinion **24** integral with disc **6**. The contour of cam surface K is selected to actuate bell crank **17** in timed relation to the longitudinal feed of feeding rods F by the rotation of rotating member **8** through slide guide **2** in such a manner that bell crank **17** is swung while the longitudinal movement of feeding rods F is stopped.

Disc **6** carries a pair of diametrically oppositely located eccentric pins E', each of said eccentric pins E' being rotatably connected to one end of each of connecting rods **7**, the other end of each of said connecting rods **7** being pivotally connected to pin R provided on each of sliders **4** which are slidably engaged with each of feeding rods F, said sliders **4** being guided by a pair of guide rods **5** secured to casing **11** in the direction transverse to the longitudinal direction of feeding rods F so that said sliders **4** are movable in the direction transverse to the length of feeding rods F. As previously described, disc **6** is reciprocably rotated in a half circle by means of pinion **24** and toothed rack portion driven by bell crank **17** actuated by cam **15** in timed relation to the longitudinal movement of feeding rods F. By this reciprocal rotation of disc **6**, feeding rods F are laterally moved in parallel toward each other and away from each other in timed relation to the longitudinal movement of feeding rods F through the disc-connecting rod device described above.

The above-mentioned timed relation between the actuation of planetary gear mechanism and disc-connecting rod device affording the successive longitudinal and lateral movements of feeding rods F is shown in FIGS. 9 and 10. As shown in FIG. 9 in which the rotating angle of the main spindle of the press is shown diagrammatically in connection with the movements of feeding rods F, angle *f* represents the angle of longitudinally feeding feeding rods F (120°, for example), idling angle i_1 (5°, for example) being provided between the end of feed angle *f* and the start of angle *u* (60°, for example) for laterally moving feeding rods F away in parallel relation away from each other so as to assure the standstill of longitudinal feed of feeding rods F before the lateral movement of feeding rods F away from each other commences thereby permitting the workpieces to be exactly positioned on each of the dies where they are to be worked. Advance angle a_1 (5°, for example) is provided at the end of angle *u* so as to commence the longitudinal returning movement of feeding rods represented by angle *r* (120°, for example) in advance of the termination of the lateral movement of feeding rods F represented by angle *u*. Advance angle a_2 (5°, for example) is also provided at the end of angle *r* so as to commence the lateral movement of feeding rods F toward each other represented by angle C (60°, for example) for grasping workpieces in advance of the termination of longitudinal returning movement of feeding rods F. Idling angle i_2 (5°, for example) is provided between the end of angle C and the start of angle *f* so as to assure the standstill of feeding rods F before longitudinal feeding movement of feeding rods F commences so that workpieces can be positively grasped by feeding rods F. The actual successive movements of feeding rods are illustrated in FIG. 10, wherein feeding movement is represented by *f*, lateral movement of feeding rods F from each other being represented by *u* which commences after the idling time represented by i_1, longitudinal returning movement being represented by *r* which commences in advance of termination of lateral movement *u* by the time period represented by a_1, lateral movement of feeding rods F toward each other being represented by C which commences in advance of termination of longitudinal returning movement *r* by the time period represented by a_2, idling time represented by i_2 being provided between the end of lateral movement C and the start of longitudinal feeding movement *f*, whereby a substantially rectangular orbit is formed by the successive movements of the feeding rods.

The disc-connecting rod device for effecting lateral movement of feeding rods F in parallel to and from each other is located at respective sides of the press at A, B as shown in FIG. 1, and actuated in synchronism to each other as shown in FIGS. 7 and 8.

Rack rods **22** extending from devices A, B at respective sides of the press are pivotably connected to rods **22'**, respectively, as shown in FIG. 7. Rods **22'** are biased by spring means **24'** as shown in FIG. 7. Each of rods **22'** is pivotably connected to the end of crank arm **25** each attached to the end of shaft **26** extending through the frame F' of the press, a pair of bearings **28** mounted in mounting members **27** at both sides of the frame rotatably supporting said shaft **26**. Each of rack rods **22** is thereby actuated in synchronism with each other so that feeding rods F are laterally moved in parallel relationship toward each other and away from each other in timed relation to the longitudinal movement of feeding rods F.

In the embodiment described above, only one planetary gear mechanism for longitudinally moving feeding rods F is utilized together with slide guide 2. It is evident that a pair of such mechanisms can be utilized so as to assure a more stable movement of the slide guide. To this end, a pair of stationary sun gears are provided in parallel to the slide guide, around each of which sun gears a planetary gear is rolled in the opposite direction symmetrically to each other or in the same direction and in the same phase with each other. The eccentric pins provided correspondingly on the planetary gears, respectively, are slidably engaged with the slide way at the lower side of the slide guide by the interposition of sliders slidably fitted with the slide ways and pivotably connected to the eccentric pins.

Since the present invention is constructed as described above, it provides smooth and efficient movement of the device for intermittently feeding workpieces simultaneously in succession with minimum acceleration and retardation of moving parts thereby permitting the operation at high speed and greater durability of the device.

I claim:

1. A device for intermittently feeding a series of workpieces simultaneously to succeeding working stations, respectively, said device being for use with a working machine such as a press having a plurality of working stations equally spaced from each other in a straight line for feed of workpieces for successive working steps; said device comprising a pair of parallel spaced feeding rods one on each side of the row of the working stations, mounting means in which said rods are mounted for laterally moving said rods toward and away from each other while keeping them parallel for simultaneously grasping the workpieces at each of the working stations and subsequently releasing them, and reciprocally longitudinally movable so as to shift the workpieces to the succeeding working stations, while the feeding rods are grasping the workpieces and back to their initial positions for intermittently feeding the workpieces, longitudinal moving means coupled to said feeding rods and comprising a planetary gear mechanism including a planetary gear movable in a circular orbit driving means coupled to said gear mechanism for driving said planetary gear in said orbit, a pin eccentrically mounted on said planetary gear coupled to said feeding rods, the diameters of the gears in said planetary gear mechanism and the eccentric throw of said pin causing the locus of the pin to describe an elliptically-shaped path having a pair of substantially linear portions on opposite sides thereof extending transversely of the feeding rods so that as the planetary gear rotates to drive said feeding rods reciprocally longitudinally, there is a dwell period as said pin is moving along said straight portions of its path, and transverse moving means coupled to said feeding rods comprising at least one pair of arcuate levers each having one end pivotally connected to the mounting means for the respective feeding rods, a rotatable disc to which the other ends of said arcuate levers are eccentrically pivoted, transmission means coupled between said disc and said gear mechanism of said longitudinal moving means for rotating said disc in timed relationship with the rotation of said gear mechanism for moving said levers to move said feeding rods toward and away from each other during said dwell periods, the speed of motion of both said longitudinal moving means and said transverse moving means being small both at the start and at the end of the movement thereof, thereby reducing the acceleration and retardation of the moving parts and assuring smooth and efficient operation of the device.

2. A device as claimed in claim 1, wherein said planetary gear mechanism includes a rotatable sun gear rotatable in a fixed position and around which said planetary gear rolls, said driving means driving said sun gear.

3. A device as claimed in claim 2, wherein said mounting means includes a slide guide slidably guided in the direction parallel to the longitudinal direction of the feeding rods, said slide guide having a slider slidable therein in the direction transverse to the direction of the length of the feeding rods and pivotally connected to said eccentric pin, said slide guide also having thereon a pair of clamping means thereon and resiliently holding the feeding rods, respectively, so that the feeding rods are moved longitudinally together with said clamping means.

4. A device as claimed in claim 1, wherein said transverse moving means comprises a pair of levers and a disc at each end of said feeding rods, said mounting means including a pair of slides in which said feeding rods are slidably mounted and to which the one ends of said levers are pivotally connected, and guide rods extending transverse to the length of the feeding rods on which said slides are slidably mounted.

5. A device as claimed in claim 1 wherein said transmission means comprises cam means, a rotating member rotatably mounted for movement relative to said planetary gear mechanism and having said planetary gear mounted thereon so as to cause said planetary gear to move in said orbit, said rotating member carrying said cam means, a pivotably mounted bell crank having one arm engaging said cam means as it rotates, a reciprocably moving rack to which the other arm of said bell crank is connected, a pinion coaxially secured to said disc with which the toothed rack is meshed, the contour of said cam means being such that said disc is rotated while said eccentric pin on said planetary gear moves along said straight portions of its path so that the feeding rods are moved toward and away from each other when the feeding rods are not moving longitudinally.

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RICHARD A. SCHACHER, Primary Examiner

U.S. Cl. X.R.

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