A drive mechanism for a press feed device which operates in synchronism with the cycling of the press but which avoids shock loads on the feed rolls at the start of each feed cycle. This is accomplished by modifying the simple harmonic drive motion derived from the rotary member of the press with a harmonic motion of a different frequency so as to produce a resultant motion having zero acceleration at the beginning and middle of each cycle.
Fig. 4

Fig. 5
This invention relates to presses and other machines of the kind which operate on successive workpieces or successive portions of elongate stock and which have at least one member which moves cyclically when the machine is operating and to which machine the stock or workpieces are required to be fed intermittently in coordination with the motion of said member.

For feeding elongate stock into machines of this kind, feeding devices are commonly provided. A common form of feed device includes rollers for engaging the stock and a linkage for driving one or more rollers from an eccentric on a rotary member of the machine, for example a crankshaft. The device further includes a one-way clutch through which drive to the roller is transmitted so that the stock is fed unidirectionally.

The driving of the feeding device from an eccentric on a rotary member causes the members of the linkage between the eccentric and the one-way clutch to execute simple harmonic motion and the members on the output side of the clutch to execute one half of this simple harmonic motion. This arrangement has a serious disadvantage in that the acceleration of the members of the feeding device is greatest at the point in each cycle at which movement of the rollers commences. This results in the application of shock loads to the feeding device and in the generation of severe vibration of members of the feeding device.

One consequence of the shock loads and vibration which arise when simple harmonic motion is applied to the feeding device is that members of the device, particularly the clutch, are subject to excessive rates of wear or to damage which seriously reduces the satisfactory working life of the feeding device. A further consequence is that the accuracy of the feeding device is impaired and variations may occur in the length of the feed step through which the stock is moved during each cycle. It is most desirable that such inaccuracy of the feeding device should be avoided, since it is common for a single portion of stock to be operated upon by more than one machine and it will be apparent that in such circumstances the length of the feed step must be reproduced exactly in each of the successive machines. Furthermore, in order to reduce the cost of workpieces made with machines of this type, it is desirable to reduce the amount of waste stock between successive workpieces formed therefrom and such waste can be substantially eliminated only when the length of the feed steps is controlled very accurately.

In view of the foregoing disadvantages, there have also been proposed feeding devices comprising a cam driven from a rotary member of the machine, the feeding roller or rollers being driven from the cam. The form of the cam can be selected to provide motion of any required character and in this way the application of simple harmonic motion to members of the feeding device can be avoided. The main disadvantage of such cam-driven feeding devices is that they are expensive.

Accordingly, it is an object of the present invention to provide a relatively inexpensive stock feeding device which avoids the disadvantages associated with the application of simple harmonic motion to members of the feeding device.

According to the invention I provide a machine comprising first and second driven elements arranged to be driven cyclically in coordination with a cyclically movable member of the machine but with respective frequencies which differ, the frequency of one element being the production of an integer and the frequency of the other element, an output element coupled to the feeding device, and means for transmitting motion from both said driven elements to said output element, the arrangement being such that the output element undergoes cyclic movement coordinated with the motion of said cyclically movable member.

The first driven element and said cyclically movable member may be arranged for movement with the same period of motion, the second driven element being arranged for movement with a period of motion which is a fraction of the period of the first driven element. Preferably, the second driven element is carried on the first driven element for movement therewith and the output element is carried on the second driven element, the second driven element being movable relative to the first driven element and the output element being movable relative to the second driven element.

With this arrangement, motion is transmitted from the first driven element to the second driven element by the bearing or other means mounting the second driven element on the first driven element, and motion is transmitted to the output element from the second driven element by a bearing or other means mounting the output element.

The output element may be arranged for motion such that the acceleration of the output element can be resolved into two simple harmonic components having the same amplitude and respective periods which differ by a factor of 3, the components being out of phase at the beginning of each cycle so that initially the output element is not accelerated. With this arrangement, the output element is not accelerated. With this arrangement, the output element remains substantially at rest for a brief initial period of each cycle and also comes substantially to rest for a brief period in the middle of each cycle.

The second driven element may be a gear wheel and there may further be provided a transmission gear wheel, both said gear wheels being mounted on the first driven element for rotation about respective axes which are parallel to but are offset from the axis of rotation of the first driven element. The transmission gear meshing with the second driven element and with a fixed gear ring so that rotation of the first driven element causes rotation of the transmission gear wheel which is transmitted to the second driven element.

The output element is conveniently mounted on the second driven element eccentrically with respect to the axis of rotation of the second driven element and is coupled by a connecting rod with a feeding device incorporated in the machine.

The feeding device may include a feeding element movable to feed stock into the machine and settable in operative and inoperative relation to the stock, the device further including setting means for setting the feeding element in operative relation to the work at the beginning of a cycle and for setting the feeding element in inoperative relation to the work in the middle of each cycle. This arrangement is especially advantageous in a case where the output element is arranged to dwell briefly at the beginning and in the middle of each cycle.

The feeding element may be a roller and may be in the form of a cylinder or of a segment or sector of a cylinder. Alternatively, feed elements in the form of recti-
linearly movable grippers adapted to grip strip material, or elements such as dial plates or jaws adapted to receive individual workpieces might be used.

The invention will now be described with reference to the accompanying drawings, wherein:

FIG. 1 shows diagrammatically a feeding device and a crankshaft of a press.

FIG. 2 is a fragmentary view of the press in end elevation showing the crankshaft and certain parts associated therewith.

FIG. 3 is a sectional view taken along the line 3—3 of FIG. 2.

FIG. 4 is a graph showing acceleration of various elements of the driving device against angular movement of the crankshaft, and

FIG. 5 is a graph showing the acceleration of the eccentric of a conventional feeding device plotted against angular movement of the crankshaft.

The invention may be applied to a power press of conventional construction comprising a C-shaped frame supporting a bed near its lower end and supporting above the bed a slide which is movable vertically relative to the frame. The bed and slide carry tools for operating on elongate stock which is fed along a path extending between the bed and slide. A crankshaft, indicated at 10 in the drawings, is supported in the frame for rotation about a horizontal axis and is coupled with the slide to cause the latter to reciprocate towards and away from the bed. The press further includes a feeding device for feeding the stock along said path at times when the tools carried on the slide are withdrawn from the stock. The feeding device is required to be inoperative when the tools carried on the slide are engaged with the stock. Thus, it is necessary for the motion of the feeding device to be coordinated with that of the crankshaft 10.

The feeding device comprises upper and lower rollers 11 and 12 respectively mounted for rotation about parallel horizontal axes. Conveniently, the lower roller 12 is mounted on a fixed support and the upper roller 11 is mounted upon a support 13 which is movable vertically. The rollers are disposed at the upper and lower sides of the stock feed path, preferably at the infed side of the press, and the rollers can be set in operative relation to the stock by lowering the roller 11 to establish pressure contact between the stock and the rollers. The rollers can be set in inoperative relation to the stock by raising the upper roller 11 clear of the stock. It will be appreciated that when the upper roller is clear of the stock, the pressure exerted on the stock by the lower roller will be very slight and there will be no significant frictional force between the roller 12 and the stock.

A cam 14 is provided for raising and lowering the upper roller 11 in co-ordination with rotation of the crankshaft 10, this cam being mounted on a horizontal shaft 15 driven by a belt drive 16 with a velocity ratio of 1 from the crankshaft. The form of the cam 14 is such that the rollers are in operative relation to the stock during one half of each cycle and are in inoperative relation during the other half of each cycle.

The lower roller 12 is driven from the crankshaft 10 through the intermediary of a drive unit 17 and a linkage 18. The upper roller 11 may be an idle roller or, as shown, it may be driven, when in its lower position, from the lower roller 12 through the intermediary of gear wheels 19, 20 carried on the spindles of rollers 11 and 12.

The drive unit 17 is illustrated in detail in FIGS. 2 and 3. A first driven element in the form of a hub 21 is rigidly mounted on an end portion of the crankshaft 10. This hub supports a pair of spindles 22, 23, respectively, which project from the hub in a direction away from the crankshaft and at positions off-set radially therefrom. The spindles are parallel to the crankshaft and the spindle 22 carries a second driven element in the form of a gear wheel 24. When the crankshaft 10 rotates, the gear wheel 24 is carried around the axis of the crankshaft with the hub 21 but is free to rotate relative to the hub about its own axis.

The spindle 23 carries a transmission gear wheel 25 which meshes with the gear wheel 24. The transmission gear wheel also meshes with an internal ring gear 26 mounted concentrically with the hub 21 and supported therefrom by an anti-friction bearing 27. The ring gear 26 is anchored to the frame 28 of the press by a linkage 29 so that it cannot rotate. When the crankshaft 10 rotates, the transmission gear wheel 25 is carried around the axis of the crankshaft by the hub 21 and is therefore caused to rotate about its own axis since it is enmeshed with the stationary ring gear 26. This rotation of the transmission gear wheel is transmitted to the gear wheel 24 which does not mesh with the ring gear 26.

An output element 30 is mounted by means of an anti-friction bearing 31 eccentrically with respect to the axis 32 of this gear wheel 24.

The linkage 18 (FIG. 1) includes a connecting rod 33 one end of which is connected to the output element 30. The other end of the rod 33 is pivotally connected with a first arm of a lever 34 which can rock about a horizontal axis. A second arm of the lever is connected with a crank arm 35 projecting radially from the spindle of the lower roller 12 by a mechanism which provides for adjustment of the amplitude of motion of the roller relative to that of the lever 34. Typically, the lever 34 and arm 35 may be connected by a rod 36, one end of which can be set a selected distance from the pivot axis of the lever 34 and the other end of which can be set a selected distance from the axis of rotation of the lower roller.

The output element 30 is constrained against rotation by the connecting rod 33. Accordingly, if the gear wheel 24 is rotated about its axis 32, the output element will oscillate upwardly and downwardly relative to this axis, the amplitude of oscillation being equal to the radius of throw r2 of the output element relative to the axis 32.

When the crankshaft 10 is rotated, the axis 32 will move around the axis of the crankshaft and accordingly the further vertical component of oscillation will be imparted to the eccentric element 30, the amplitude of this further component being equal to the distance, r1, by which the axis 32 is off-set from the axis of the crankshaft.

The gear wheel 24 has a number of teeth equal to one-half the number of teeth on the internal ring gear 26. The gear wheels 24 and 25 are carried around the axis of the crankshaft 10 while the ring gear is stationary. Accordingly, drive is transmitted from the crankshaft to the gear wheel 24 with a velocity ratio of 3 so that the periodic time of the first component of vertical oscillation applied to the output element 30 is one third the periodic time of the second component of vertical.
3,914,977 oscillator applied thereto. In order that the corresponding components of acceleration applied to the output element should, at the beginning of each cycle, be of the same magnitude, the spacing \( r_1 \) of the axis 32 from the axis of the crankshaft is nine times the radius of throw \( r_2 \) of the output element 30 with respect to the axis 32.

In FIGS. 2 and 3, the parts are shown in the positions they occupy at the commencement of a feeding cycle, i.e. when the tool carried on the slide of the press have been withdrawn from the stock and a further length of stock is to be fed into the press. It will be evident that during the initial part of each cycle, the two components of vertical oscillation applied to the output element 30 act in opposite directions. Initially, the axis 32 moves downwardly relative to the axis of the crankshaft 10 and the output element 30 moves upwardly relative to the axis 32. For all practical purposes, these two components of motion exactly cancel one another during an initial stage of each cycle so that the output element 30 dwells briefly in the position shown in FIGS. 2 and 3.

Since the eccentricity of the axis 32 with respect to the axis of the crankshaft 10 is nine times that of the output element 30 with respect to the axis 32, the output element 30 eventually moves downwardly thereby rocking the lever 34 and turning the rollers, which at this stage are in operative relation to the stock, in a direction to feed stock into the press. The output element reaches its lowest position just before the crankshaft has rotated 180° and, for all practical purposes, the output element dwells briefly in this lowest position at the middle of each cycle. Thus, the rollers 11 and 12 are at rest for a brief period at the middle of the cycle and during this brief period the roller 11 is raised to its inoperative position. Accordingly, when the output element 30 commences to move upwardly and the rollers turn in the reverse direction, such reverse movement of the rollers is not imparted to the stock.

The distance through which the stock is fed during each cycle can be adjusted by adjustment of the rod 36 relative to the pivot axis of the lever 34 and relative to the spindle of the lower roller 12.

In FIG. 4, the curve 37 shows that component of the acceleration imparted to the output element 30 which corresponds to movement of the axis 32 about the axis of the crankshaft 10. The curve 38 represents that component of the acceleration imparted to the output element which corresponds to movement of the output element relative to the axis 32 when the gear wheel 24 rotates. The sum of these two components of acceleration is represented by the curve 39. It will be noted from the initial portion of the curve 39 that at the beginning of each cycle the acceleration of the output element is zero, the components of acceleration represented by the curves 37 and 38 being of equal magnitude but opposite in direction.

For comparison, there is shown in FIG. 5 a curve 40 representing the acceleration imparted to the feeding device of a conventional press by a single eccentric on the crankshaft. In the case of such a conventional press, the acceleration imparted to the feeding device is a maximum at the beginning of each cycle. With the arrangement shown in the accompanying drawings, the acceleration imparted to the feeding device is zero at the beginning and at the middle of each cycle and increases smoothly from zero so that the application of shock loads to members of the feeding device is avoided.

On comparing curves 37 and 39 it will be seen that the motion of the output element 30 is coordinated with that of the crankshaft 10, in that when the crankshaft reaches the end of a cycle of its motion, the output element also reaches the end of a cycle of its motion.

While it is preferred that the two components of motion applied to the output element have respective periods which differ by a factor of 3, the velocity ratio of the transmission from the crankshaft 10 to the second driven element 24 could be such that the respective periods of these components of motion differ by a factor which is some integer other than 3. Such alternative transmission ratios would enable the application of initial shock loads to members of the feeding device to be avoided, but may not cause the output element to dwell at the middle of each cycle. In such circumstances, the movement of the feeding rolls into and out of operative relation with the stock may lead to inaccuracy of the feed step. Instead of providing means for moving the feeding rolls into and out of operative relation with the stock, the feeding device may incorporate a one-way clutch through which drive is transmitted to the rollers so that the latter rotate unidirectionally.

In many cases, the linkage through which drive is transmitted from the drive unit 17 to the feeding elements will distort the motion somewhat, i.e., a curve representing the motion of the feeding elements will not correspond exactly to a curve representing the motion of the output element. In such a case, it may be advantageous to vary the ratio \( r_1 \) to \( r_2 \) slightly from the exact square of the velocity ratio of the drive between the crankshaft 10 and the gear wheel 24. In this way, at least partial compensation can be made for distortion of the motion which results from the geometry of the linkage.

1. A stock feed device for a press having a cyclically movable member, feed elements for moving the stock through the press, and a means operated by said cyclically movable member for driving the feed elements, said driving means including a first driven element operating with a simple harmonic motion coordinated with the motion of said cyclically movable member, a second driven element carried by said first driven element and operating with a simple harmonic motion having a frequency equal to the product of an integer and the frequency of said first driven element, an output element actuated by said second driven element, and means connecting said output element with said feed elements to thereby drive the feed elements with a motion composed of two simple harmonic components corresponding to the motions of the respective driven elements.

2. The stock feed device of claim 1, wherein the acceleration of the output element is composed of two simple harmonic components of equal amplitude and having frequencies which differ by a ratio of 1 to 3.

3. The stock feed device of claim 1, wherein the harmonic acceleration components of the output element are 180° out of phase at the beginning of each feed cycle.

4. A stock feed device for a press having a crankshaft, feed elements for moving the stock through the press and means operated by the crankshaft for driving
the feed elements, said driving means including a hub on said crankshaft, a gear wheel journaled on said hub with its axis parallel to, but offset from, the axis of said crankshaft, a fixed ring gear disposed with its axis coinciding with the axis of said crankshaft, a transmission gear journaled on said hub and meshing with said ring gear and said gear wheel, an eccentric on said gear wheel, an output element journaled on said eccentric, and means connecting said output element with said feed elements whereby said feed elements are operated with a motion composed of two simple harmonic components corresponding to the motions of the gear wheel axis relative to the crankshaft axis and the eccentric axis relative to the gear wheel axis.

5. The stock feed device of claim 4, wherein the frequencies of the two simple harmonic components differ by a ratio of 1 to 3 and the eccentricities of the gear wheel axis and eccentric differ by a ratio of 9 to 1.

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Disclaimer


Hereby enters this disclaimer to all claims of said patent.