Oct. 12, 1943. E. D. DILLING 2,331,540

AUTOMATIC FEED DEVICE

Filed Jan. 23, 1943 2 Sheets-Sheet 1

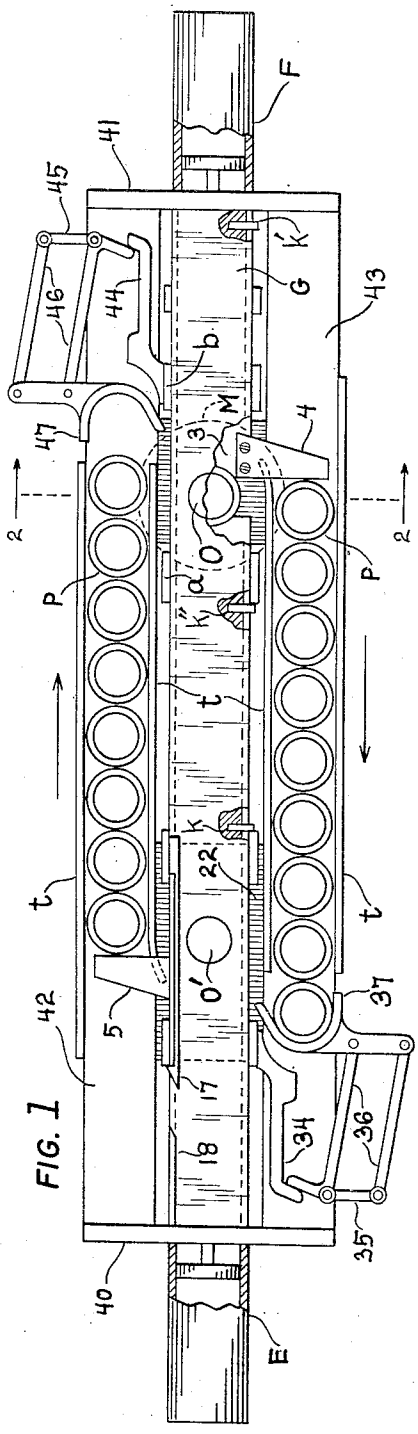


FIG. 1

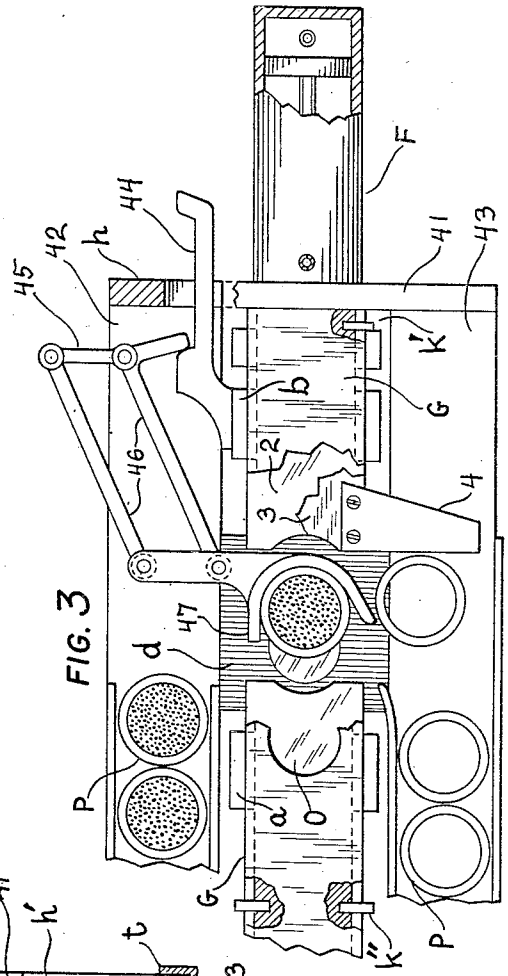


FIG. 3

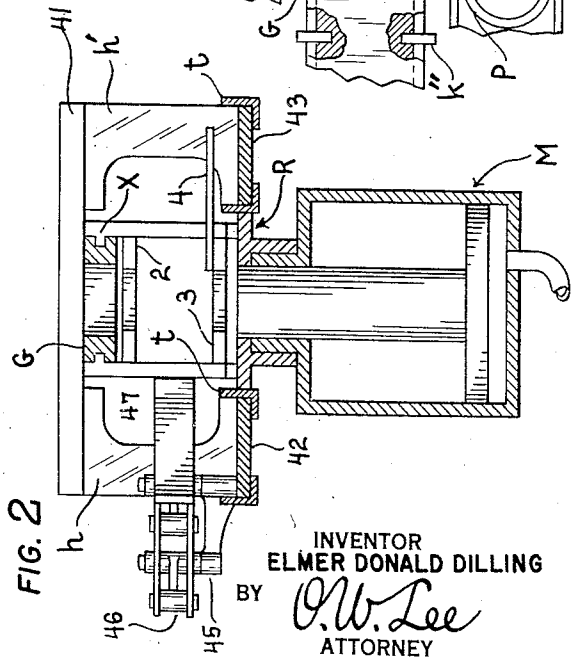


FIG. 2

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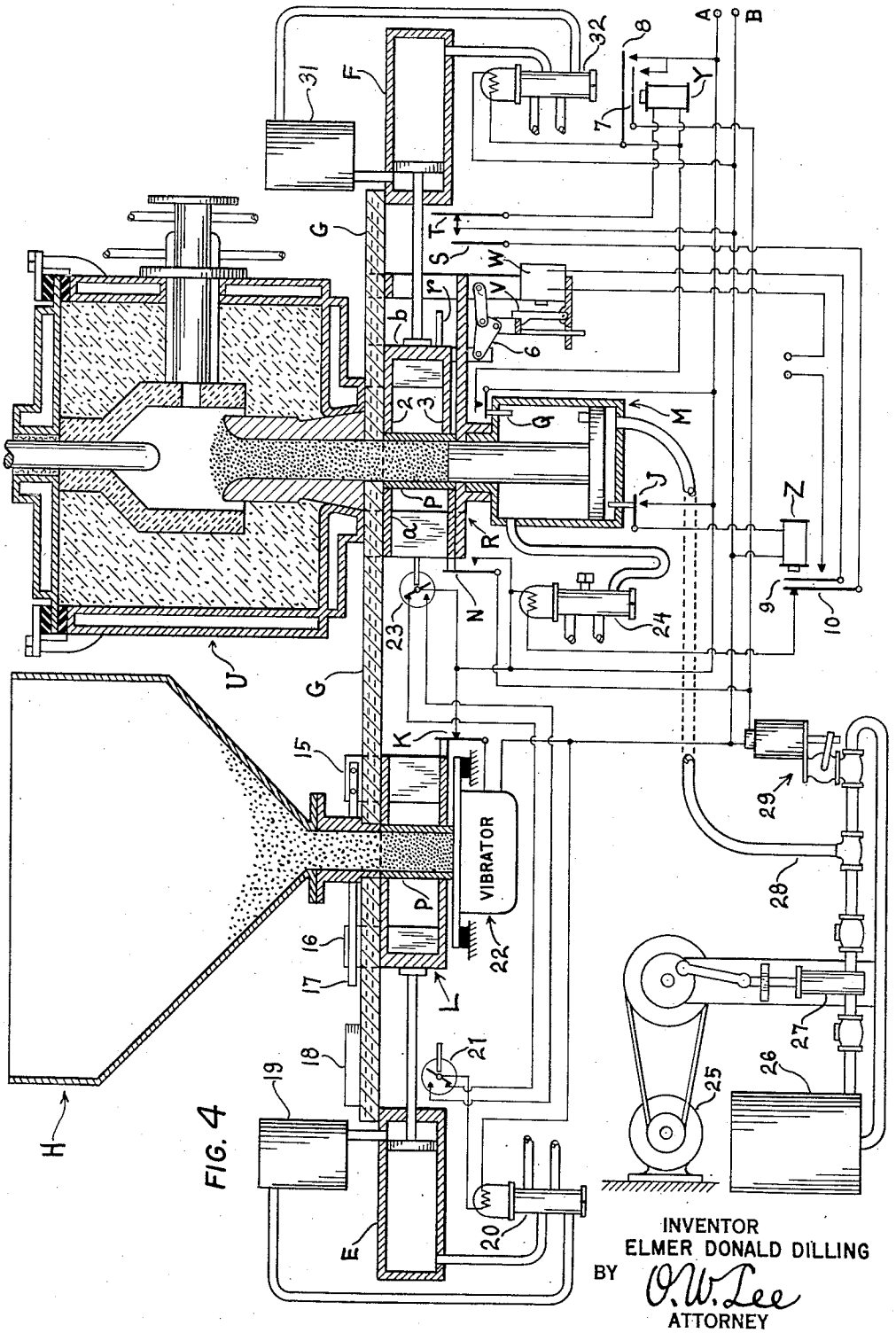


FIG. 4

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Patented Oct. 12, 1943

2,331,540

UNITED STATES PATENT OFFICE

2,331,540

AUTOMATIC FEED DEVICE

Elmer Donald Dilling, Pullman, Wash., assignor to Henry A. Doerner, Pullman, Wash.

Application January 23, 1943, Serial No. 473,323

10 Claims. (Cl. 214—1)

My present invention relates to certain new and useful improvements in an automatic feed device and is of particular advantage in continuously feeding material into a thermal reduction furnace such as disclosed in the patent application Serial No. 372,293 of Henry A. Doerner, wherein the present invention is also disclosed and Mr. Doerner therein acknowledges that I am the sole inventor thereof.

The thermal reduction of magnesium oxide and carbon produces magnesium metal in a highly pyrophoric form and therefore the feed port of the thermal reduction furnace must be kept well closed at all times. Successful feeding of the dry powdered materials presents various problems and difficulties which the present invention effectually overcomes in a practical and efficient manner. The material must be fed into the furnace at the same rate that it is consumed. If the rate of feed is too slow, the temperature rises and the refractory walls of the furnace are destroyed, if the rate of feed is too fast, the unreacted material soon clogs the furnace. The rate of feed must be gradual, so as to avoid temperature fluctuations within the thermal reduction furnace, because the rate of feed and the power input must be in direct proportion to each other and so controlled as to maintain proper temperature conditions within the furnace. The materials must be tightly packed in the feed port, because otherwise, condensation products will form a hard deposit in the materials and clog the feed port.

Due to the height of the column of material required to enter the furnace, any attempt to feed the loose materials into the furnace with a hydraulic ram, wastefully consumes the effect of the ram, in packing the materials, and therefore detracts from the rate of feed.

To overcome the various difficulties which these problems present, the present invention first packs the dry powdered materials into open end cartridges, and then a hydraulic ram is used to push the tightly packed charge out of each cartridge and into the feed port of the furnace. The materials are packed into each cartridge by an electric vibrator placed at the filling position, and a hydraulic ram is used to move these packed cartridges in a continuous train to the furnace where means are provided to separately register each cartridge under the feed port of the furnace, whereupon the packed material is pushed out of the cartridge and into the furnace by a hydraulic ram. A hydraulic ram is used to move the empty cartridges in a continuous train, back to the filling position where means are provided to separately register each cartridge at the filling position. These three hydraulic rams are operated by magnetic valves which are controlled by electrical circuits which are operated by the various movements of the device, so as to afford a timed relationship and sequence, at various speeds at which the feeding may be required.

The drawings show the preferred form in which the invention has been reduced to practice and successfully used in actual operation to feed the thermal reduction furnace during the production of magnesium metal.

Fig. 1 is a plan view of the invention.

Fig. 2 is an enlarged vertical section, taken on the line 2—2 of Fig. 1, but omitting the cartridges, so as to disclose the operative parts.

Fig. 3 is an enlarged plan view of the right hand end of Fig. 1, showing the actuated position of the elements, part of the top plate being broken away to disclose the underlying parts.

Fig. 4 is a longitudinal vertical section disclosing the lateral carriages in their relationship to a hopper and a thermal reduction furnace, and includes a wiring diagram.

As shown in the drawings, the invention employs two reciprocating carriages which are generically indicated as L and R. These carriages are slidably mounted in longitudinal guideways in the top plate G in the manner best seen at X in Fig. 2. Rams E and F are mounted at the opposite ends of the top plate G, and the piston rods of these rams are connected to the respective carriages L and R so as to provide reciprocating movements of the carriages. The left carriage L comprises two separable sections 15 and 16 which are linked together by a latch 17 which is lifted at an appointed position by a cam 18 as is best seen in Fig. 1 and Fig. 4. The right carriage R also comprises two separable sections *a*—*b* which are linked together by the toggle lever 6 which is held in position by a latch V which can be disengaged by the electric magnet W so that the movement of the ram F can separate the sections of the carriage for removal of the cartridge P shown clamped therebetween in Fig. 4 and Fig. 1.

As indicated in Fig. 4 the outer section *b* of the carriage R has upper and lower jaws 2—3, and as shown in Fig. 3 these jaws are shaped so as to form a centering device for the cartridge P. The illustrated arcuate jaws are preferable because they afford more contact with the round

cartridges; however, a V-notch jaw will suffice for the purpose of centering. The jaws of the inner section of the carriage are also shown with arcuate jaws, however a straight face will suffice on these inner jaws, and the outer jaws alone can be relied upon for centering. The illustrated shape is preferable because there is less wear when the contact is thus more extensive. The jaws of the left carriage L are the same as shown in Fig. 3.

As shown in Fig. 1, the top plate G is provided with an aperture O' which constitutes the filling port and an aperture O which constitutes the feed port. The carriages are registered with these ports by suitable stops such as *k* and *k''*. Similar stops such as *k'* limit the outward movement of the right carriage R. The vibrator 22 is yieldably mounted in position to support a cartridge in the carriage L at the filling port O'.

The hydraulic ram M is mounted on the underside of the right carriage R and moves bodily with this carriage, because when this ram completes its upward stroke it is necessary to move the carriage to the right so as to cover the feed port before this ram begins its downward stroke.

As shown in Fig. 1 and Fig. 2, the top plate G supports crossbars 40 and 41 to which are attached brackets such as *h* and *h'* by means of which there is supported at the level of the carriage R and on opposite sides thereof, a pair of runways 42 and 43, and rails such as *t* are employed to provide tracks along which the filled cartridges are moved in one direction and the empty cartridges returned in the opposite direction, so as to provide a continuous train. As indicated by the shaded area 22, the top plate of the vibrator, bridges the gap between the runways 42 and 43; and as indicated in Fig. 3 by the shaded area *d*, the bottom plate of the right carriage is widened to bridge the gap between these runways.

The cross movement of the cartridges is accomplished by levers which are actuated by a cam carried by the outer section of each carriage. For this purpose, there is secured to the right end of the runway 42, a bracket 45 upon which there is fulcrumed a lever 46 which is in the nature of a bell-crank lever with parallel bars. This lever carries fingers 47 which fit around a cartridge. A cam ram 44 is attached to the outer section *b* of the carriage R so as to move therewith and actuate this lever 46 in the manner illustrated in Fig. 3 where the ram F is shown in its outermost position. When this ram F is returned to its innermost position as shown in Fig. 1 the cam 44 then operates the lever 46 to hold the fingers 47 in position to receive a cartridge. Similar structure is shown at 34, 35, 36 and 37 for the left carriage, and the operation is the same.

As shown in Fig. 1 and Fig. 3, the jaw 3 of the outer section of the right carriage is provided with an arm 4 which pushes the train of empty cartridges towards the fingers 37 of the lever 36. The left carriage is provided with a similar arm 5 which pushes the train of filled cartridges towards the fingers 47. The ram E begins its outward stroke at the same time as the upward stroke of the ram M but operates much faster than the latter, and therefore the first phase of the operation will actuate the lever 36 and remove the empty cartridge from the fingers 37 and push a filled cartridge into the fingers 47 in readiness for the subsequent operation shown in Fig. 3.

The rams E, M and F are operated by pressure through the magnetic valves 20, 29 and 32 and the magnetic valve 24 supplies the pressure for lowering the ram M. The ram E is provided with an oil reservoir 19 which is subjected to air pressure from the valve 20 which alternately supplies air pressure to the opposite side of this ram. Thus one side of the ram is operated by air pressure and the opposite side by oil under air pressure, as this provides a more even control than would otherwise be afforded by air pressure alone. It will of course be understood that the inlet to this valve is connected to an air pressure line which is common to the valves 20, 24 and 32, and need not be here shown. To remove any oil froth, it is advisable to connect the exhaust of these three valves to a suitable reservoir, but that expedient is not here shown. The ram F is provided with a reservoir 31 and magnetic valve 32 which are duplicates of the structure just described.

The underside of the ram M is connected by a flexible conduit 28 to the constantly operated pump 27 which is supplied with oil from the tank 26, and a magnetically operated by-pass valve 29 is used to control the directional flow from the pump. The lowering of the ram M is accomplished by air pressure supplied through the magnetic valve 24 which is connected thereto by a flexible conduit, the opposite outlet of this valve being closed by a cap as shown.

The operation of the device is rendered automatic by the electrical diagram shown in Fig. 4. Electrical power is supplied to the trunk lines A and B. The line B is directly connected to the valve 20, the vibrator 22, the by-pass valve 29, the relay Z, the valve 32, and also connected to the relay Y through the spring closed switch T. The three-way switches 21 and 23 alternately connect the line A to the valve 20. The spring opened switch K connects the line A to the vibrator 22. The spring closed switch N connects the line A to the by-pass valve 29 which is also connected to the line A through the normally open switch 7 of the relay Y. The valve 24 is indirectly connected to the line B through the normally open switch S and the normally closed switch 10 of the relay Z which is connected through the normally open switch J to the line A. This relay Z also includes a normally open switch 9 which connects the magnet W to a power source which may be the lines A—B or else a separate power source as here shown, in case it is desired to use a D. C. magnet, and A. C. current for the valves, or vice versa. The normally open switch Q connects the line A to the relay Y which then connects the line A to the valve 32 through the switch 8 which is also connected to the relay Y to render it self locking. It will of course be understood that this wiring diagram is merely for the convenience of illustration, and that in actual practice, the well known micro switches are employed to assure quick operation of the switches at the critical moment intended.

From the foregoing description it will be seen that when the switch Q is closed, it will energize the relay Y which will then provide its own circuit through the switch 8 after the switch Q is opened, and the relay will remain locked until the switch T is opened so as to deprive this relay of current from the opposite side of the line. It will also be seen that this relay Y energizes the by-pass valve 29, and also energizes the valve 32 to cause the ram F to move the carriage R outward,

whereupon the by-pass valve 29 then has an additional connection through the closing of the switch N so that opening of the switch T will reverse the valve 32 but will not affect the by-pass valve 29.

In the absence of current the valves 20 and 32 supply pressure to the outer ends of the rams E and F, and the valve 24 is in the exhaust position. The by-pass valve 29 is normally closed, and is opened when current is supplied thereto. The ram E operates at a much faster rate than the upward stroke of the ram M and the former operates in both directions in much less time than is required for the latter to complete its upward stroke. The outward movement of the ram F is in two stages, between which the carriage R is held stationary by the toggle lever 6, because the plunger of the ram M must be completely out of the cylinder P before the lever 46 is operated to insert a filled cartridge and remove the empty.

In Fig. 4 the ram M is shown raised just sufficiently to open the switch J so that all of the switches will be in their initial position. Here, there is a packed cartridge P in register with the hopper H and another packed cartridge P in register with the feed port of the thermal reduction furnace U. In this position the right carriage R operates the switch 23 to supply current to the valve 20 and quickly move the left carriage L outward so as to cover the port in the hopper, whereupon the cam 18 lifts the latch 17 so as to separate the inner section 15 from the outer section 16 which continues to move outward and actuate the lever 36 to push an empty cartridge into the carriage and the filled cartridge out into the line of travel. The completed movement of the carriage L operates the switch 21 to cause the valve 20 to reverse the ram E and move the carriage back to its initial position with the empty cartridge in register with the port of the hopper, which movement also causes the arm 5 to move the entire train of filled cartridges towards the right and place a filled cartridge in the empty fingers 47, the described action having left the fingers 37 without any cartridge therein. The ram E then holds the carriage L in position to close the switch K and supply current to the vibrator 22 so as to pack the dry powdered material in the cartridge. During this action the normally closed by-pass valve 29 has caused the constantly operated pump 27 to supply pressure to the underside of the ram M to gradually push the packed material out of the cartridge and into the feed port of the furnace.

When the ram M completes its upward stroke, it closes the switch Q to energize the relay Y and supply current through the switch 7 to energize the by-pass valve 29 and open the by-pass so as to leave the ram M in its ascended position. This energizing of the relay Y also supplies current through the switch 8 to operate the magnetic valve 32 so as to cause the ram F to move the right carriage R outward until it contacts the stop K' whereupon the carriage closes the switch S so as to supply current to the valve 24 to quickly lower the ram M until the full downward stroke closes the switch J to energize the relay Z and open the switch 10 to break the circuit to the valve 24 and release its pressure upon the ram M. This energizing of the relay Z also closes the switch 9 which supplies current to the magnet W to disengage the latch V and release the toggle lever 6 so that the ram F can move the outer section *b* of the carriage outward so as to actuate the lever 46 in the manner shown in Fig. 3 which moves a packed cartridge onto the carriage and pushes the empty out into the return train. The full movement of the section *b* causes the pin *r* to open the switch T and break the circuit to the relay Y, whereupon the switch 8 opens to cause the valve 32 to reverse the ram F and quickly move the carriage to its original position. It will be noted that this also opens the switch 7 which connects to the by-pass valve 29, however this valve also has a current supply through the switch N which is closed during all of these movements, so that the by-pass valve 29 is supplied with current to hold it open at all times except when the carriage R is in register with the feed port, which position holds the switch N open as illustrated and the switch 23 in position to start another cycle.

The disclosed embodiment assures coordination of the various movements in proper sequence, and the pump 27 can be driven at various speeds without destroying the proper sequence. In actual practice the speed of the motor is controlled by a rheostat, either manually or automatically, in accordance with the temperature at an appropriately selected point within the thermal reduction furnace, which can be readily determined by a thermocouple connected to a potentiometer; however, those expedients need not be here shown. The invention is highly satisfactory for this exacting purpose, and it is also quite probable that it has a broader field of utility.

In the disclosed embodiment, each of the controls are electrically operated, as that is preferable; however, the invention is intended to embrace reasonable variants, as for instance, the electrically operated toggle lever 6 may be supplanted by any suitable form of latch, mechanically disengaged by the down stroke of the ram M. It is intended that other modifications may be made within the scope of the following claims and their reasonable equivalents.

In the present disclosure, I claim as my invention:

1. In an automatic feed device, a slidably mounted carriage including a separable section connected thereto by a magnetically releasable latch, a ram secured to said carriage and operating through the bottom thereof for passage through a cartridge held between said sections of the carriage, electrically controlled means operated by said carriage in its initial position to gradually raise said ram, electrically controlled means operated by a self-locking relay energized by said ram in its elevated position to move said carriage to an appointed position, electrically controlled means operated by said carriage at said appointed position to quickly lower said ram, electrically controlled means operated by said ram in its lowered position to magnetically unlatch said separable section for further movement controlled by said self-locking relay, a lever operated by the independent movement of said separable section for moving a cartridge into said carriage and pushing one therefrom, a switch opened by the movement of said separable section to break the circuit to said self-locking relay and return said carriage to its initial position ready to begin another cycle.

2. An automatic feed device comprising a slidably mounted carriage including a separable section connected thereto by a magnetically releasable latch, a ram secured to said carriage and operating through the bottom thereof for

passage through a cartridge held between said sections of the carriage, electrically controlled means operated by said carriage in its initial position to gradually raise said ram, electrically controlled means operated by a self-locking relay energized by said ram in its elevated position to move said carriage to an appointed position, electrically controlled means operated by said carriage at said appointed position to quickly lower said ram, electrically controlled means operated by said ram in its lowered position to magnetically unlatch said separable section for further movement controlled by said self-locking relay, a lever operated by the independent movement of said separable section for moving a cartridge into said carriage and pushing one therefrom, a switch opened by the movement of said separable section to break the circuit to said self-locking relay and return said carriage to its initial position ready to begin another cycle, cartridge packing means, and means to move filled and empty cartridges in an endless train to and from said carriage and said packing means.

3. An automatic feed device comprising a slidably mounted carriage including a separable section connected thereto by a magnetically releasable latch, a ram secured to said carriage and operating through the bottom thereof for passage through a cartridge held between said sections of the carriage, electrically controlled means operated by said carriage in its initial position to gradually raise said ram, electrically controlled means operated by a self-locking relay energized by said ram in its elevated position to move said carriage to an appointed position, electrically controlled means operated by said carriage at said appointed position to quickly lower said ram, electrically controlled means operated by said ram in its lowered position to magnetically unlatch said separable section for further movement controlled by said self-locking relay, a lever operated by the independent movement of said separable section for moving a cartridge into said carriage and pushing one therefrom, a switch opened by the movement of said separable section to break the circuit to said self-locking relay and return said carriage to its initial position ready to begin another cycle; a second carriage slidably mounted and including a separable section connected thereto by a latch so as to retain a cartridge movable therewith, electrically controlled means operated by said first carriage in its initial position to move said second carriage outwardly, a cam for unlatching this separable section as it continues to move outward, a lever operated by the independent movement of this separable section for moving a cartridge into this carriage and pushing one therefrom, a switch operated by this separable section to break its existing circuit and return this carriage to its initial position, an electric vibrator, a switch held closed by this carriage at its initial position for operating said vibrator; and arms carried by said carriages for moving cartridges in opposite directions in an endless train.

4. An automatic feed device comprising a slidably mounted carriage including a separable section connected thereto by a magnetically controlled latch, a ram secured to said carriage and operating through the bottom thereof for passage through a cartridge held between said sections of the carriage, a second ram for moving said carriage in and out of its initial position, electrically controlled means to raise the first said ram while said carriage is in its initial position, electrically controlled means operated by the first said ram in its ascended position to cause said second ram to move said carriage to an appointed position, electrically controlled means for lowering said first ram at this appointed position, electrically controlled means operated by the lowering of said first ram to unlatch said sections of the carriage for removal and replacement of a cartridge therebetween, electrically controlled means operated by the separation of said sections to reverse said second ram and return said carriage to its initial position.

5. An automatic feed device comprising a slidably mounted carriage including a separable section connected thereto by a magnetically controlled latch, a ram secured to said carriage and operating through the bottom thereof for passage through a cartridge held between said sections of the carriage, a second ram for moving said carriage in and out of its initial position, electrically controlled means to raise the first said ram while said carriage is in its initial position, electrically controlled means operated by the first said ram in its ascended position to cause said second ram to move said carriage to an appointed position, electrically controlled means for lowering said first ram at this appointed position, electrically controlled means operated by the lowering of said first ram to unlatch said sections of the carriage for removal and replacement of a cartridge therebetween, electrically controlled means operated by the separation of said sections to reverse said second ram and return said carriage to its initial position, cartridge packing means, and means to move filled and empty cartridges in an endless train to and from said carriage and said packing means.

6. An automatic feed device comprising a slidably mounted carriage including a separable section connected thereto by a magnetically controlled latch, a ram secured to said carriage and operating through the bottom thereof for passage through a cartridge held between said sections of the carriage, a second ram for moving said carriage in and out of its initial position, electrically controlled means to raise the first said ram while said carriage is in its initial position, electrically controlled means operated by the first said ram in its ascended position to cause said second ram to move said carriage outwardly to an appointed position, electrically controlled means for lowering said first ram at this appointed position, electrically controlled means operated by the lowering of said first ram to unlatch said separable section for continued outward movement by said second ram, a lever operated by the independent movement of said separable section for moving a cartridge into this carriage and pushing one therefrom, a switch operated by this separated section to reverse said second ram and return said carriage to its initial position, a second carriage slidably mounted and including a separable section connected thereto by a latch so as to retain a cartridge movable therewith, a third ram for moving said second carriage in and out of its initial position, electrically controlled means operated by said first carriage in its initial position to cause said third ram to move said second carriage outwardly, a cam for unlatching this separable section as it continues to move outward, a lever operated by the independent movement of this separable section for moving a cartridge into this second carriage and pushing one therefrom, a switch operated by this separated section to reverse said third

ram and return said second carriage to its initial position, an electric vibrator, a switch held closed by said second carriage at its initial position for operating said vibrator, and arms carried by said carriages for moving cartridges in opposite directions in an endless train.

7. An automatic feed device comprising a slidably mounted carriage embodying two separable sections linked together by a magnetically controlled latch, a ram secured to said carriage and operating through the bottom thereof for passage through a cartridge held between said sections of the carriage, electrically controlled means for raising said ram at the initial position of said carriage, and then moving said carriage and ram to an appointed position and lowering said ram, then magnetically unlatching said sections and separating them while removing and inserting a cartridge in said carriage, then returning said carriage and ram to their initial position to start another cycle, the movements of said carriage and said ram operating the various controls for the different phases of each cycle in a fixed sequence, cartridge packing means, and means to move filled and empty cartridges in an endless train to and from said carriage and said packing means.

8. In an automatic feed device, a slidably mounted carriage embodying two separable sections linked together by a magnetically controlled latch, a ram secured to said carriage and operating through the bottom thereof for passage through a cartridge held between said sections of the carriage, electrically controlled means for raising said ram at the initial position of said carriage, and then moving said carriage to an appointed position and lowering said ram, then magnetically unlatching said sections and separating them while removing and inserting a cartridge in said carriage, then returning said carriage to its initial position to start another cycle, the movements of said carriage and said ram operating the various controls for the different phases of each cycle in a fixed sequence.

9. An automatic feed device comprising a slidably mounted carriage including a separable section latched thereto, a ram secured to said carriage and operating through the bottom thereof for passage through a cartridge held between the latched sections of said carriage, a second ram for moving said carriage in and out of its initial position, means operated by said carriage in its initial position to raise the first said ram, means operated by the first said ram in its ascended position to cause said second ram to move said carriage to an appointed position, means operated by said carriage at this appointed position for lowering said first ram, means operated by the lowering of said first ram to unlatch said separable section of the carriage, a lever operated by the independent movement of this separated section for moving a cartridge into said carriage and pushing one therefrom, means operated by this separated section to reverse said second ram and return said carriage to its initial position, a second carriage slidably mounted and including a separable section connected thereto by a latch so as to retain a cartridge movable therewith, a third ram for moving said second carriage in and out of its initial position, means operated by said first carriage in its initial position to cause said third ram to move said second carriage outwardly, a cam for unlatching this separable section as it continues to move outward, a lever operated by the independent movement of this separated section for moving a cartridge into this second carriage and pushing one therefrom, means operated by this separated section to reverse said third ram and return said second carriage to its initial position, and arms carried by said carriages for moving cartridges in opposite directions in an endless train.

10. In an automatic feed device, a slidably mounted carriage embodying two separable sections latched together, a ram secured to said carriage and operating through the bottom thereof for passage through a cartridge held between said sections of the carriage, means operated by said carriage in its initial position to gradually raise said ram, means operated by the raising of said ram to move said carriage to an appointed position, means operated by said carriage at said appointed position to lower said ram, means operated by the lowering of said ram to unlatch said sections for separation, a lever operated by the separation of said carriage for removing and inserting a cartridge between said sections, means operated by the separation of said carriage to reverse its movement and return the same to its initial position.

ELMER DONALD DILLING.

CERTIFICATE OF CORRECTION.

Patent No. 2,331,540. October 12, 1943.

ELMER DONALD DILLING.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, first column, line 50, for "cam ram" read --cam arm--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 29th day of February, A. D. 1944.

Leslie Frazer

(Seal) Acting Commissioner of Patents.

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