

Jan. 21, 1958

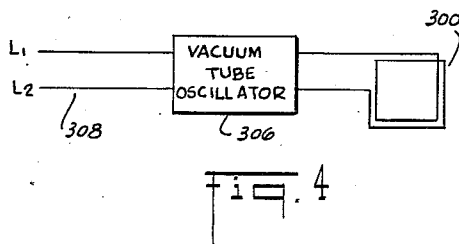
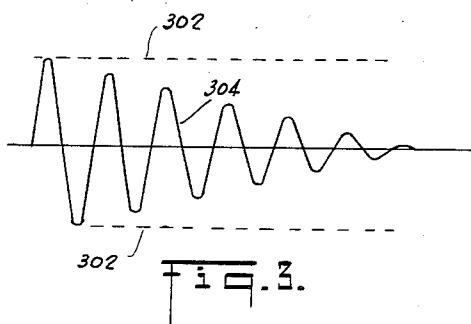
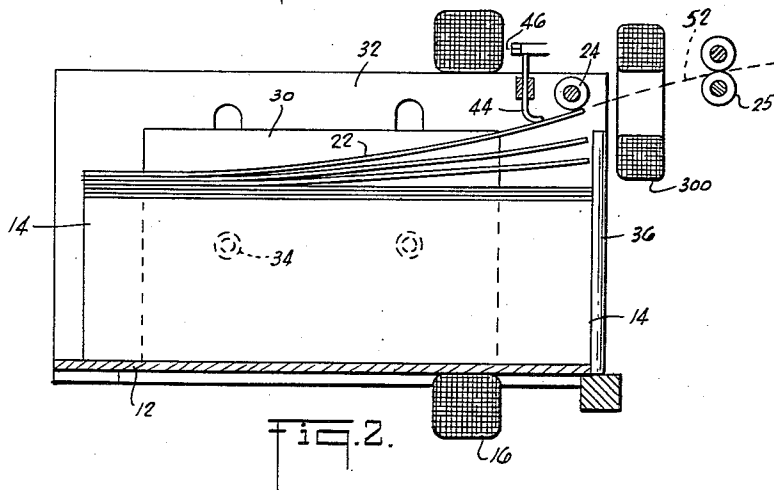
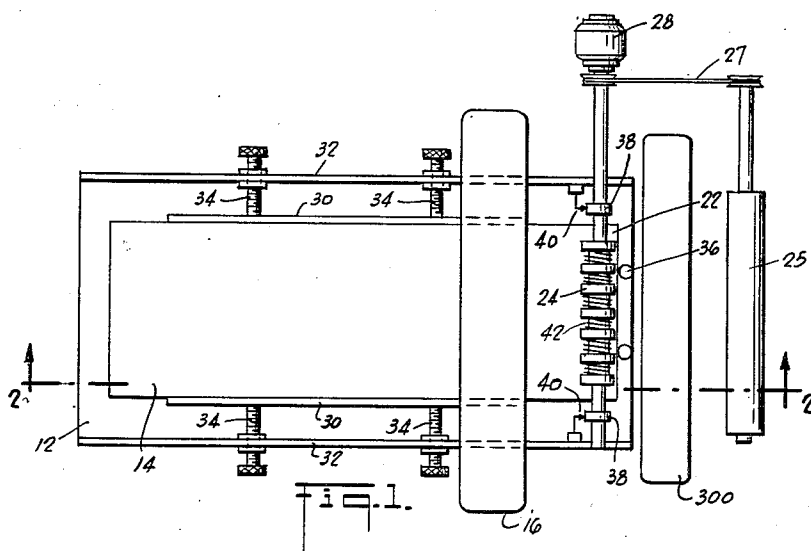
A. FOWLER

2,820,632

DE-MAGNETIZER FOR MAGNETIC FEED SYSTEM

Filed June 4, 1953

2 Sheets-Sheet 1



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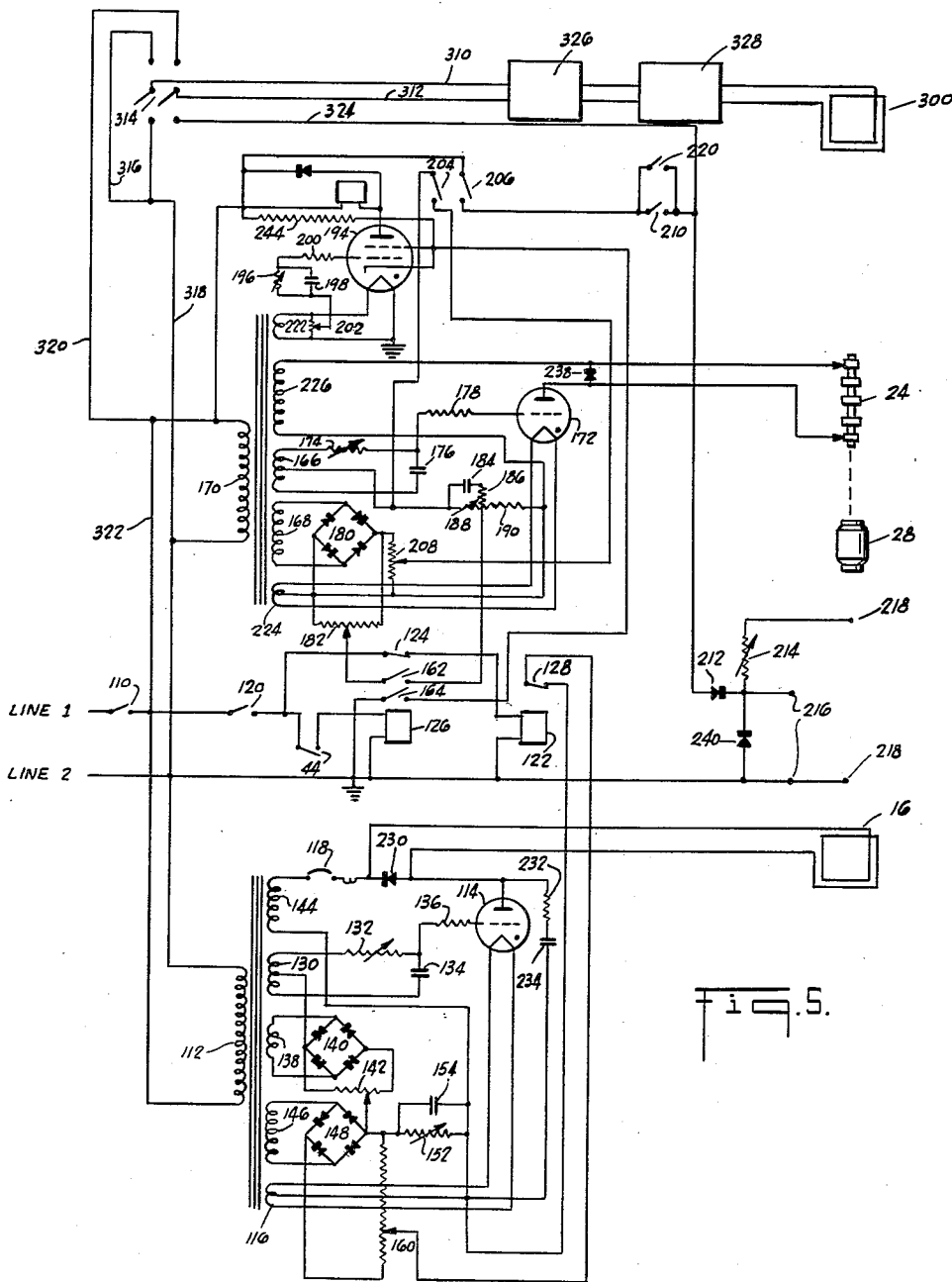
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2 Sheets-Sheet 2



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DE-MAGNETIZER FOR MAGNETIC FEED SYSTEM

Alexander Fowler, Stamford, Conn.

Application June 4, 1953, Serial No. 359,573

5 Claims. (Cl. 271—18)

This invention relates to magnetic feed systems, and more particularly to a de-magnetizer for the same.

In my copending applications Serial No. 129,662, filed November 26, 1949, and Serial No. 226,656, filed May 16, 1951, now Patent No. 2,661,208 of Dec. 1, 1953, I disclose magnetic sheet feed systems in which the uppermost sheet of a stack is raised and separated magnetically, the said sheet reaching a magnetic feed roller which feeds the sheet out from the stack. Inasmuch as the sheets are ferrous or ferromagnetic, they may retain residual magnetism. For certain purposes it may prove undesirable to leave residual magnetism in the sheets, and one object of the present invention is to provide de-magnetizing means. Another object is to improve my aforesaid sheet feed apparatus by combining the same with de-magnetizing means adapted to eliminate residual magnetism caused by said apparatus.

In my aforesaid apparatus the sheet feed roller may be energized continuously, but I prefer to provide means for energizing the same intermittently in properly timed relation, thus economizing in the use of power. In accordance with a further feature and object of the present invention the de-magnetizer may also be excited only intermittently and in properly timed relation, in order to conserve in the consumption of power.

To accomplish the foregoing general objects, and other more particular objects which will hereinafter appear, my invention resides in the sheet separating, feeding, and de-magnetizing elements, and their relation one to another, as are hereinafter more particularly described in the following specification. The specification is accompanied by drawings, in which:

Fig. 1 is a plan view of sheet separating, feeding, and de-magnetizing apparatus embodying features of my invention;

Fig. 2 is a section taken in elevation approximately in the plane of the line 2—2 of Fig. 1;

Fig. 3 is explanatory of the theory of the invention;

Fig. 4 is a schematic representation of a modification for use with exceptionally high speed apparatus; and

Fig. 5 is a schematic wiring diagram for a complete apparatus energized from a single phase power supply.

Referring to the drawing, and more particularly to Figs. 1 and 2, the apparatus comprises a bed or table 12 for supporting a stack of sheets 14, and an induction coil 16 which extends entirely around the stack 14 and the table 12. The axis of the coil extends in the direction in which the sheets are to be fed, which in this case is horizontally, from left to right. The apparatus further includes an electromagnetic feed roller 24 capable of feeding sheet 22 with the latter disposed beneath the roller. The roller is driven by motor 28. The latter may rotate one or more sets of later feed rollers, indicated schematically at 25, through a drive 27.

The sheets may be stacked between guide plates 30, supported within side plates 32, preferably by means of adjusting screws 34, so that sheets of different width

may be accommodated. The sheets are aligned at their forward edge by means of front stops such as the posts 36.

The slip rings 38 (Fig. 1) and brushes 40 supply magnetizing current to the coils 42 of the feed roller 24. A feeler 44 (Fig. 2) controls switch contacts 46. When the topmost sheet 22 reaches the feed roller 24 the feeler closes the normally open contacts 46. This showing is merely schematic.

In accordance with the present invention the magnetic feed roller 24 is immediately followed by a de-magnetizer coil 300. This is large enough in diametrical dimension to pass the sheets. More specifically, it is large enough in horizontal direction to pass the widest sheet to be handled by the apparatus, and it is dimensioned high enough in vertical direction to provide adequate clearance despite possible variation in the path taken by the sheet as it is delivered by the rollers. The coil has sufficient windings and a suitable impedance relative to the supply voltage to provide adequate excitation for the de-magnetizing operation.

The theory underlying the de-magnetizing operation may be explained with reference to Fig. 3 of the drawing. The coil 300 (Figs. 1 and 2) is supplied with an alternating current of constant magnitude, as indicated by the lines 302 (Fig. 3). However, the sheet is in motion, and in respect to any transverse zone or increment of the sheet it is excited a maximum amount when that increment is in the plane of the coil 300, and the excitation falls away or is effectively damped as it leaves the coil and becomes more and more remote. This is illustrated by the damped wave shown at 304, and the excitation falls away to substantially zero. The excitation is alternating, and if at fairly high frequency relative to the speed of travel of the sheet, it will be seen that the increment at which the excitation approaches zero, or reaches the lowest value that is capable of re-orienting the molecules in the increment, will be at random along the sheet, so that some molecules of the sheet may face one way and others face another way, depending on their last orientation just as the excitation became too feeble to further change the orientation of the molecules. Of course, if the molecules distributed along the sheet are oriented in different directions, the sheet has been de-magnetized.

For most practical purposes ordinary power line frequency of 60 cycles per second is sufficiently high to accomplish the desired de-magnetization. However, if the apparatus feeds sheets at exceptionally high speeds, so that it becomes desirable to increase the frequency of alternation in order to make certain of relatively random disposition of the molecules, the frequency may be stepped up by using a suitable means, such as a motor generator, or vacuum tube oscillator. Thus referring to Fig. 4, the vacuum tube oscillator 306 is energized from an ordinary 60 cycle power line 308, and the much higher frequency output of the oscillator is supplied to the de-magnetizing coil.

Attention is next directed to Fig. 5 of the drawing, but by way of general introduction it may be explained that most of this diagram corresponds to one of a number of different systems disclosed in my aforesaid patent applications, for energizing the induction coil 16 and magnetic feed roller 24 of Figs. 1 and 2. This circuit provides the induction coil 16 with a rising or so-called "growth current" each time the coil is energized to raise another sheet, and as explained in my copending applications, if the induction coil is energized in this manner the topmost sheet tends to be raised from the next subjacent sheet before the latter is raised at all, whereupon both rise before the third sheet rises, so that the fanning out or divergence or separation of the sheets

is maintained as the induction coil is further energized. In any event the topmost sheet alone reaches the feed roller, and the induction coil may then be de-energized without danger of the feed roller holding more than one sheet.

The specific system of Fig. 5 employs a thyatron, and fires the thyatron by means of a trigger wave. The main induction coil of the apparatus receives the D. C. or rectification increments. The trigger wave is shifted, and this provides a growth current because of the increasing increments of plate current as the firing point of the thyatron changes.

The plate and grid waves of the thyatron may be of like frequency and each of uniform magnitude, but relatively shiftable in phase. With the waves 180° out of phase no current will flow. At intermediate values the current supplied by the thyatron may be varied by shifting the phase of the trigger wave supplied to the grid. On the other hand the trigger wave and the plate wave may be given a phase difference which is maintained constant, and the axis of the trigger wave may be raised or lowered by changing the magnitude of a bias superimposed thereon. This also has the effect of varying the plate current, and because either method or a combination of both may be employed I prefer to use the broad term "shift" in respect to the trigger wave, in order to include either a phase shift or a bias shift, or both.

Referring to Fig. 5, the main coil is shown at 16, and the magnetic feed roller at 24, the latter being driven by a motor 28. The trip switch is shown at 44. The de-magnetizing coil is shown at 300. Single phase power is supplied at lines 1 and 2.

When the main switch 110 is thrown on, the transformer 112 is energized, heat the filament of thyatron tube 114, through secondary 116. After the tube is warmed up a circuit breaker 118 is closed, and then the operating switch 120 is closed, which starts the cycle as follows:

Relay 122 is energized from line 1 through the normally closed contacts 124 of relay 126, which is still de-energized because the trip switch 44 is open. Actuation of relay 122 opens the contacts 128. When contacts 128 of relay 122 open the growth current starts and the sheets begin to separate. The growth current is obtained from the transformer secondary 144, and is controlled by thyatron 114. A trigger wave is supplied from transformer secondary 130 to the grid.

The resistor 132 and capacitor 134 provide a phase shifting circuit for the trigger wave. The series resistor 136 limits the grid current. Resistor 132 of the phase shifting circuit is variable to permit fine control of the phase relation of trigger wave or grid voltage to plate voltage.

Secondary 138 of transformer 112, in conjunction with full-wave rectifier 140 and potentiometer 142, provides a positive D. C. grid potential or bias which raises the axis of the trigger wave and so increases the amount of plate current fed through the main sheet separating coil 16. This bias may be set for the maximum desired amount of thyatron plate current. Transformer secondary 146 and rectifier 148 supply a negative bias to lower the axis of the trigger wave. The thyatron plate current is in alternate or positive half waves. The trigger wave from secondary 130 has its phase displaced by the resistor and capacitor 132, 134, and has its horizontal axis raised by the bias supply 138, 140, the amount being adjustably controlled by potentiometer 142. As the circuit goes into operation, however, the effect of the rectifier circuit 146, 148 is to pull the axis of the wave down again. It is initially pulled down to a point where none, or if desired, only a small chip of plate current flows. The amount that it is pulled down then decreases by reason of an R. C. decay circuit 152, 154. As the axis of the A. C. grid voltage wave rises its point of firing of the thyatron keeps moving effectively to the

left, thus causing larger and larger chips of plate current to flow through the thyatron. Potentiometer 160 is an additional current control which may or may not be required in a particular application. It controls how far the A. C. wave is brought down. Controls 142 and 160 overlap and it is not essential to have both.

The energization of the main coil 16 causes the sheet to rise until it reaches the magnetic roller 24 and the trip switch 44, closing the latter, and energizing the relay 126, which functions to magnetize the feed roller 24 and to start the feed motor 28. In the particular circuit here shown the magnet coils of the feed roller 24 are energized through a thyatron tube 172 controlled much as previously described, but with a view to providing two widely different stages or uniform amounts of magnetization of the feed roll, as well as a complete cut-off when the feed roll is not in use. A relatively small magnetization is adequate to hold the topmost sheet while the main coil 16 is being de-energized to permit descent of the other sheets. A substantially higher degree of magnetization is employed to actually feed the sheet.

Energization of relay 126 opens contacts 124, de-energizing relay 122, and permitting contacts 128 to again close. This bucks the trigger wave elevating potential of thyatron 114, and so collapses (either completely or partially) the field in the main coil 16. The field in the main coil is collapsed because the trigger wave axis is lowered by rectifier supply 146, 148, thus pulling the A. C. trigger wave down to the point where the thyatron does not fire (or fires at desired minimum).

At the same time relay 126 also closes its contacts 162 and 164. Contacts 162 initiate the cycle of the upper thyatron tube 172 with the aid of secondaries 166 and 168 of transformer 170. Secondary 166 provides the trigger wave, and resistor 174 and capacitor 176 provide the phase shift of the trigger wave, which controls the firing of the thyatron and so controls the degree of energization of the magnetic roller 24. The resistor 178 limits grid current.

Secondary 168, through rectifier 180 and potentiometer 182, through relay contacts 162 leading to the capacitor 184 and resistors 186, 188, 190 provide positive grid potential to thyatron 172, thereby causing whatever plate current is required to energize the magnetic roller at its lower stage of magnetization.

Contacts 164 initiate the operation of a time delay relay built around tube 194. Tube 194 is used with a decay circuit to act as a timer to delay rotation of the feed roller after the sheet has reached the roller (as indicated by closing of the trip switch 44). The time delay here is accomplished through grid rectification by means of resistor 196 and capacitor 198. The resistor 200 is used to limit grid current.

Because of grid rectification the capacitor applies a negative potential on the grid of the tube, and plate current does not flow. However, when the contacts 164 close the charge stored in capacitor 198 during the grid rectification period then discharges through the grid circuit 200, 196, 198, 202, 222, and when the discharge has reached a certain point the tube will fire. It is this time required for discharge that results in the desired time delay action of the circuit.

When the tube 194 fires, a relay 192 is energized, closing contacts 204 and 206. Contacts 204 increase the current through magnetic roller 24 by supplying more positive potential than previously applied through contacts 162 of relay 126 to the grid of thyatron 172. For this purpose the adjustment of potentiometer 208 is made higher than that of potentiometer 182. At the same time the closing of relay contacts 206 energizes the feed motor 28 through switch 210, rectifier 212, and rheostat 214.

As so far described the operation would be wholly automatic, the delivery of one sheet following another, but in many applications a manual or pedal control is wanted,

and for this purpose it is merely necessary to add any convenient form of manual or pedal switch 220 in parallel with the switch 210 previously mentioned, the latter then being opened or omitted, and the switch 220 being a normally open switch. The motor is a shunt motor symbolized at 28, but electrically the terminals 216 represent the connections to the field of the motor, while the terminals 218 represent the connections to the armature of the motor.

When the sheet leaves the feed roller 24 the trip switch 44 opens and relay 126 is de-energized. This opens contacts 162 and 164, and permits closing of contacts 124. The opening of contacts 164 cuts off the current flow through tube 194, de-energizing relay 192, and opening contacts 204 and 206. The opening of contacts 206 stops the motor. The opening of contacts 204, in conjunction with the opening of contacts 162 of relay 126, completely de-energizes the roller after elapse of a time interval caused by the delay circuit 184, 186 and 188. The closing of contacts 124 operates relay 122, thereby opening contacts 128, and so again initiating the growth current in the main sheet separating coil 16. This causes the cycle to repeat.

In a simpler form the circuit of Fig. 7 might provide for continuous fully automatic feed of sheets, one immediately after the other, with continuous energization of the feed motor 28 and the feed roller 24. In slightly more complex form the feed roller may be de-energized between feed operations. In still more complex form the feed roller may be energized with two degrees of magnetization, a lesser one for holding but not feeding a sheet, and a stronger one for feeding the sheet. In the present circuit there is the still further refinement of prolonging the full energization or magnetization of the roller beyond the rotation of the motor, a feature particularly useful for partial or incremental sheet feed, and also to energize the de-magnetizer coil, as explained later.

Circuit breaker 118 is used in this circuit to protect the thyatron 114, and the main coil, and to act as a cut-off device if the tube is operated at maximum load for too long a time. The circuit breaker includes a thermal time delay mechanism to take care of the possibility of a sheet not being raised. If no sheet is raised to the trip switch 44 after, say four seconds, the main coil 16 is cut off.

Secondary 116 of transformer 112 is the filament heating source for thyatron 114. Transformer secondary 222 of transformer 170 is used to heat the cathode of tube 194. The plate circuit of this tube is supplied directly from the line, rather than from a transformer secondary. Secondary 224 of transformer 170 is used to heat the cathode of thyatron 172. Secondary 226 of transformer 170 is used to supply plate current to thyatron 172, and consequently to magnetize the feed roller 24.

The rectifier 230 is a "back rectifier" across the main coil 16 and is used to give increased life to thyatron 114, and incidentally add energy to the main coil 16. An alternate idea which might be used but is thought less preferable is the use of a shunt circuit 232, 234 across the thyatron 114, this being a series R. C. circuit of very small current value to just effect the proper commutation time of the tube.

This back rectifier idea has here been employed also in connection with the feed roller circuit and even in connection with one of the relay circuits. Specifically the back rectifier 238 serves the purpose of improving commutation of thyatron 172 and at the same time adding energy to the circuit. The back rectifier of tube 194 is indicated at 242 and provides additional energy in the non-conducting cycle of tube 194, the additional energy going to relay 192. Resistor 244 is used in the circuit to connect the cathode and screen grid to the plate circuit to aid in grid rectification for the timing circuit.

The de-magnetizing coil 300 shown in the upper right-hand corner of Fig. 5 is energized through wires 310, 312.

The energization may be continuous, and a circuit for that purpose is obtained by throwing the double pole double throw switch 314 to upward position, in which case wire 310 is connected through wires 316 and 318 to line 2, while wire 312 is connected through wires 320 and 322 to line 1.

However, for economy in the consumption of electricity the de-magnetizer coil 300 may be energized intermittently, and a circuit for this purpose is obtained by throwing the switch 314 to downward position, in which case the wire 310 is again connected through wire 318 to line 2, but the wire 312 is connected through wire 324 to the switch 210 previously referred to. This connects into the circuit which rotates the magnetic feed roller 24 which, it will be recalled, is rotated only intermittently during feed of a sheet. It therefore follows that the de-magnetizer coil 300 is also energized only intermittently, and also in properly timed relation if, as is here shown, the de-magnetizer coil is physically located immediately following the magnetic feed roller.

This does not mean that one must locate the de-magnetizer coil close to the feed roller. It may be spaced a substantial distance from the feed roller, but in that case it may either be energized continuously by throwing the switch 314 to upward position, or it may be energized intermittently as previously described, but with a time delay relay interposed, so that the energization of the de-magnetizer takes place an appropriate amount of time later than the rotation of the magnetic feed roller. Such a relay is shown at 326.

For exceptionally high speed delivery a frequency step-up means may be introduced, as explained in connection with Fig. 4. Such a means is indicated at 328 in Fig. 5. If it be a vacuum tube oscillator, the filament heater may be energized by wires brought in separately for continuous heating, even when the de-magnetizer coil 300 is energized only intermittently, so that the oscillator response will be instantaneous.

To summarize the operation of the circuit of Fig. 5, thyatron 114 acts as a valve to control the main sheet lifting coil 16. There are two bias circuits, one of which (138, 140, 142) elevates, and the other of which (146, 148, 160) depresses the trigger wave, the latter being effective when the main coil is not functioning, and the former being effective when it is. The growth of the plate current takes place because the trigger wave axis is raised by discharge of potential from the decay circuit 152, 154.

Thyatron 172 acts as a valve to control the magnetization of the feed roller 24. The height of the axis of the trigger wave is established by bias potential supplied by transformer secondary 168, rectifier 180 and potentiometer 182. This is adjusted to supply the needed current for the sheet holding stage. The magnetization is increased during the sheet feeding stage by raising the trigger wave axis.

If it be desired to delay the start of the sheet feeding operation until after ample time for collapse of the main field and the fanned sheets, such delay is provided by a time delay circuit associated with tube 194 and using R. C. circuit 196, 198. The delay in firing of tube 194 delays both rotation and full magnetization of the feed roller. If it be desired to briefly continue full energization of the roller after the motor stops, in order to compensate for inertia of the moving sheet, such prolongation is provided by the time delay or decay circuit 184, 186, 188. This may be used to continue the excitation of the de-magnetizing coil 300, without using a time delay relay at 326, to insure decay of excitation for the increments in the trailing end of the sheet.

The sheets are de-magnetized by their passage through the de-magnetizer coil 300, the motion of the sheet corresponding to a damping of the excitation to zero, even though the actual excitation may be uniform. Since the

polarity of the excitation of the coil alternates at a frequency which is high relative to the speed of travel of the sheet, the molecules are left in random positions, and the sheet is de-magnetized.

It is believed that the construction and operation, as well as the advantages of my improved apparatus for separating and feeding sheets, will be apparent from the foregoing detailed description thereof.

It will also be apparent that while I have shown and described the invention in a preferred form, changes may be made in the structure disclosed without departing from the scope of the invention as sought to be defined in the following claims. In some claims there is reference to a top sheet, and to the raising of a top sheet to a magnetic feed roller above the stack, but this is to be understood primarily in a relative sense, because the sheets need not necessarily be initially stacked in horizontal position.

I claim:

1. In combination, a magnetic feed roller for feeding lengths of ferromagnetic material, a source of power for exciting said magnetic feed roller, means to intermittently energize the feed roller for the successive feeding operations, de-magnetizing means for ridding the material of residual magnetism, said de-magnetizing means comprising a coil disposed with its axis in the approximate direction of motion of the material and large enough in diametral dimension to permit the material to pass through the coil in the course of the feed movement produced by said feed roller, and a source of alternating current power connected to said coil, the level of energization of the coil during treatment of a length of the material being maintained substantially constant but the individual increments of the material being subjected to alternating magnetization which falls off or decays because of the travel of the increment through and away from the coil, exciter means to intermittently excite the de-magnetizing coil, and means to time said exciter means to make the demagnetizing coil effective during the passage of a length of material therethrough.

2. In combination, de-magnetizing means for ridding ferromagnetic sheets of residual magnetism, means for feeding said sheets through said de-magnetizing means, said de-magnetizing means comprising a coil disposed with its axis in the approximate direction of motion of the sheets and large enough in diametral dimension to permit the sheets to pass through the coil in the course of the feed movement, and a source of alternating current power connected to said coil, the level of energization of the coil during treatment of a sheet being maintained substantially constant but the individual increments of the sheet being subjected to alternating magnetization which falls off or decays because of the travel of the sheet through and away from the coil, the frequency of alternation of the alternating current being made sufficiently high relative to the speed of travel of the sheet to result in a random disposition of the molecules in the material, exciter means to intermittently excite the de-magnetizing coil, and means to time said exciter means to make the demagnetizing coil effective during the passage of the sheets therethrough.

3. In combination, a long magnetic feed roller for feeding sheets of ferromagnetic material, a source of power for exciting said magnetic feed roller, means to intermittently energize the feed roller for the successive feeding operations, de-magnetizing means for ridding the sheets of residual magnetism, said de-magnetizing means comprising a coil disposed with its axis in the approximate direction of motion of the sheets, said coil having rectangular turns and being large enough in diametral dimension to permit the sheets to pass through the coil in the course of the feed movement produced by said feed roller, and a source of alternating current power

connected to said coil, the level of energization of the coil during treatment of a sheet being maintained substantially constant but the individual increments of the sheet being subjected to alternating magnetization which falls off or decays because of the travel of the increment through and away from the coil, the frequency of alternation of the alternating current being made sufficiently high relative to the speed of travel of the sheet to result in a random disposition of the molecules in the sheet, exciter means to intermittently excite the de-magnetizing coil, and means to time said exciter means to make the demagnetizing coil effective during the passage of the sheet through the coil.

4. In combination, intermittently operable magnetic means to raise and separate the uppermost sheet of a stack of ferromagnetic sheets, said means being an induction coil which extends entirely around the stack with its axis in the approximate direction of motion for delivery of the sheets, means to intermittently excite said induction coil, means to receive and feed the uppermost sheet out from the stack, and de-magnetizing means for ridding the sheets of residual magnetism, said de-magnetizing means comprising a coil disposed with its axis in the approximate direction of motion of the sheets, said coil having rectangular turns and being large enough in diametral dimensions to permit the sheets to pass through the coil in the course of the feed movement produced by said feed roller, and a source of alternating current power connected to said coil, the level of energization of the coil during treatment of a sheet being maintained substantially constant but the individual increments of the sheet being subjected to alternating magnetization which falls off or decays because of the travel of the sheet through and away from the coil, the frequency of alternation of the alternating current being made sufficiently high relative to the speed of travel of the sheet to result in a random disposition of the molecules in the material, exciter means to intermittently excite the de-magnetizing coil, and means to time said exciter means to make the demagnetizing coil effective during the passage of the sheet through the de-magnetizing coil.

5. In combination, intermittently operable magnetic means to raise and separate the uppermost sheet of a stack of ferromagnetic sheets, said means being an induction coil which extends entirely around the stack with its axis in the approximate direction of motion for delivery of the sheets, and means to intermittently excite said induction coil, a magnetic feed roller for feeding the sheets of ferromagnetic material, a source of power for exciting said magnetic feed roller, means to intermittently energize the feed roller for the successive feeding operations, de-magnetizing means for ridding the sheets of residual magnetism, said de-magnetizing means comprising a coil disposed with its axis in the approximate direction of motion of the sheets and large enough in diametral dimension to permit the sheets to pass through the coil in the course of the feed movement produced by said feed roller, and a source of alternating current power connected to said coil, the level of energization of the coil during treatment of a sheet being maintained substantially constant but the individual increments of the material being subjected to alternating magnetization which falls off or decays because of the travel of the sheet through and away from the coil, the frequency of alternation of the alternating current being made sufficiently high relative to the speed of travel of the material to result in a random disposition of the molecules in the material, and exciter means to intermittently excite the de-magnetizing coil, said means being timed to make the demagnetizing coil effective during the passage of sheets through the de-magnetizing coil.

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