

Sept. 1, 1953

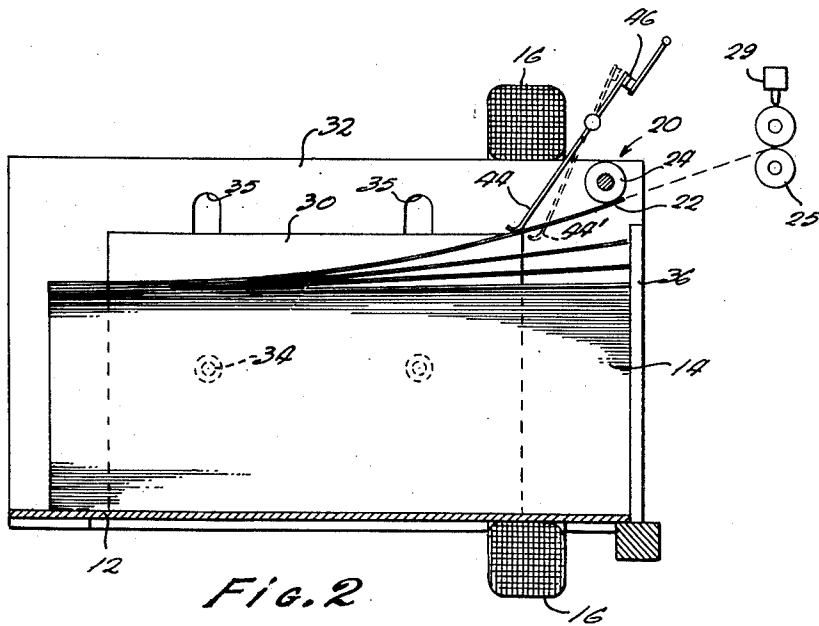
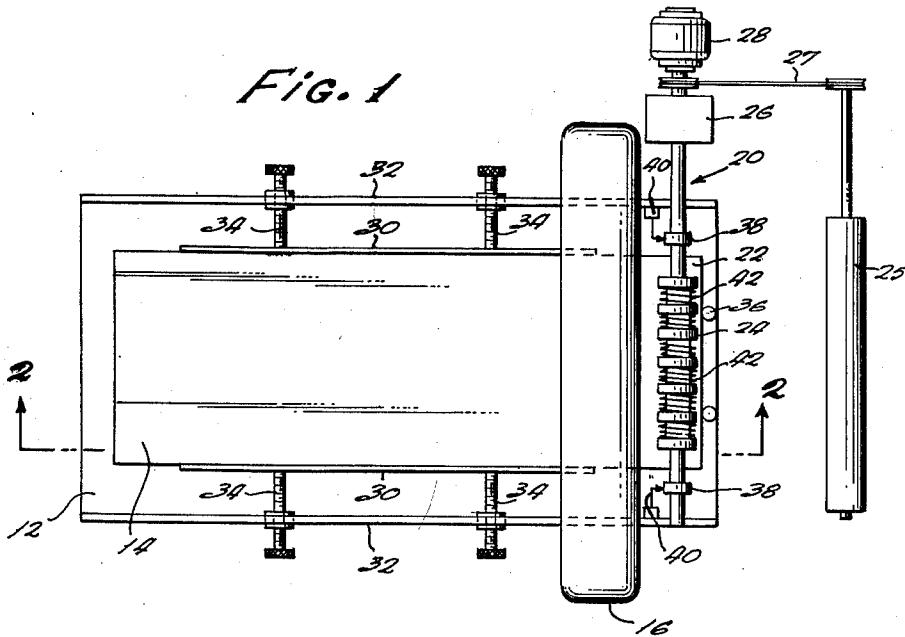
A. FOWLER

2,650,824

FEEDING OF MAGNETIC SHEET MATERIAL

Filed Nov. 26, 1949

4 Sheets-Sheet 1



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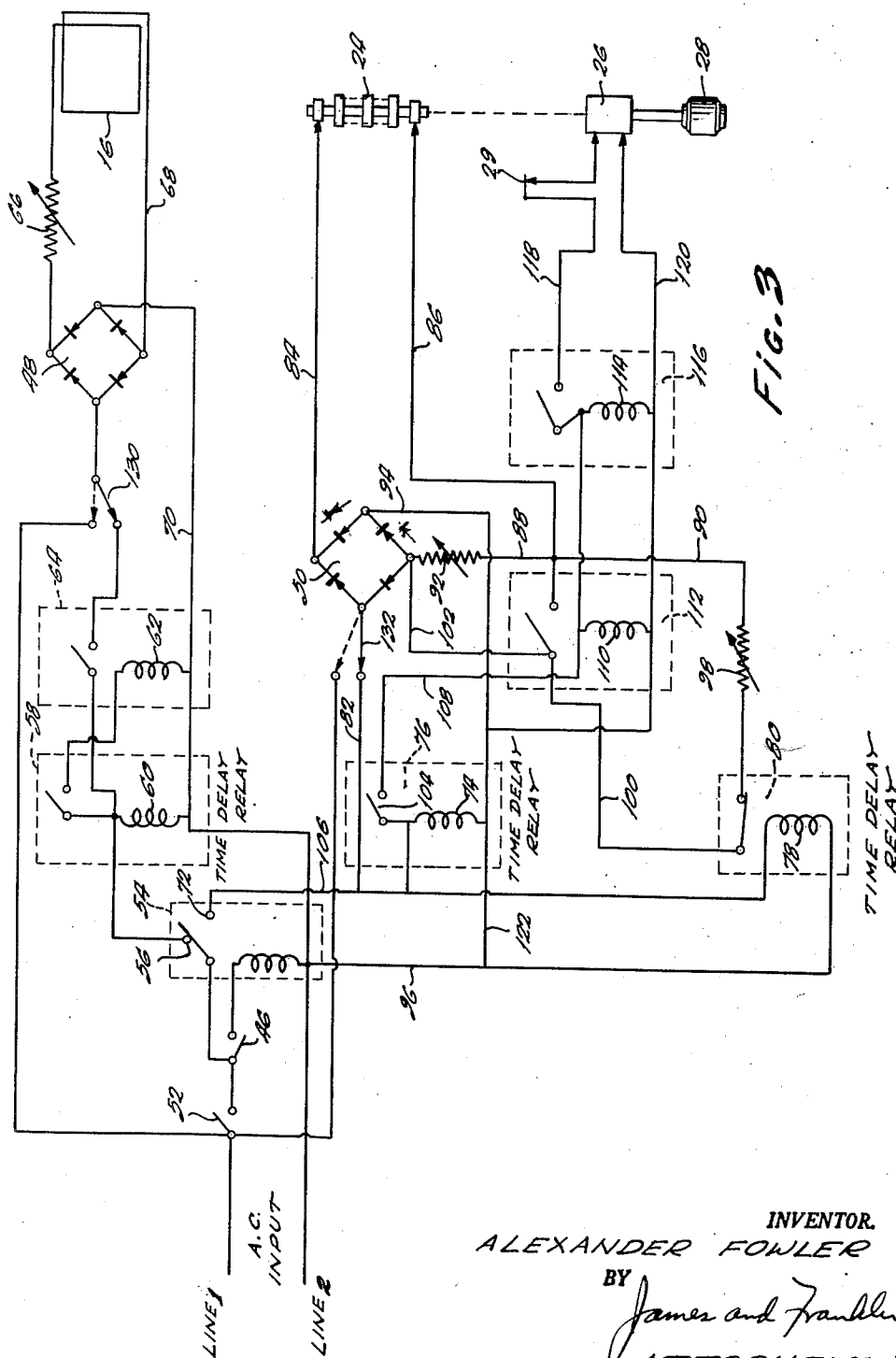
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4 Sheets-Sheet 3

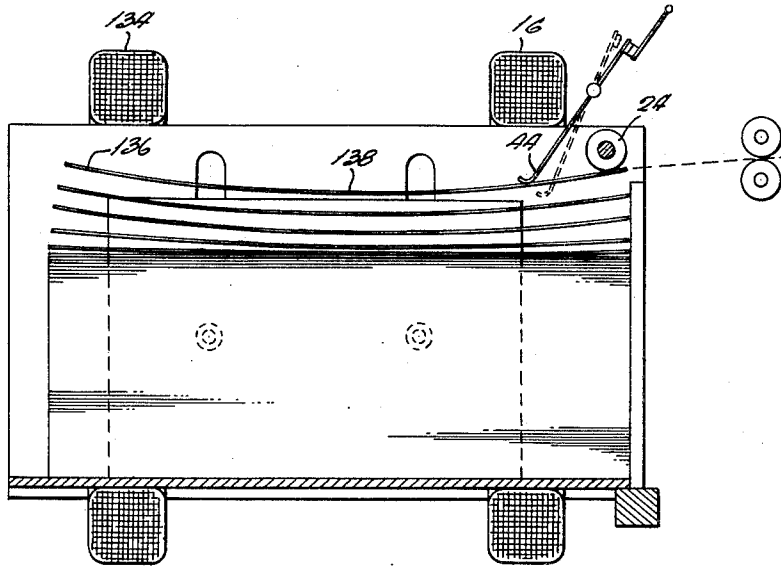


Fig. 4

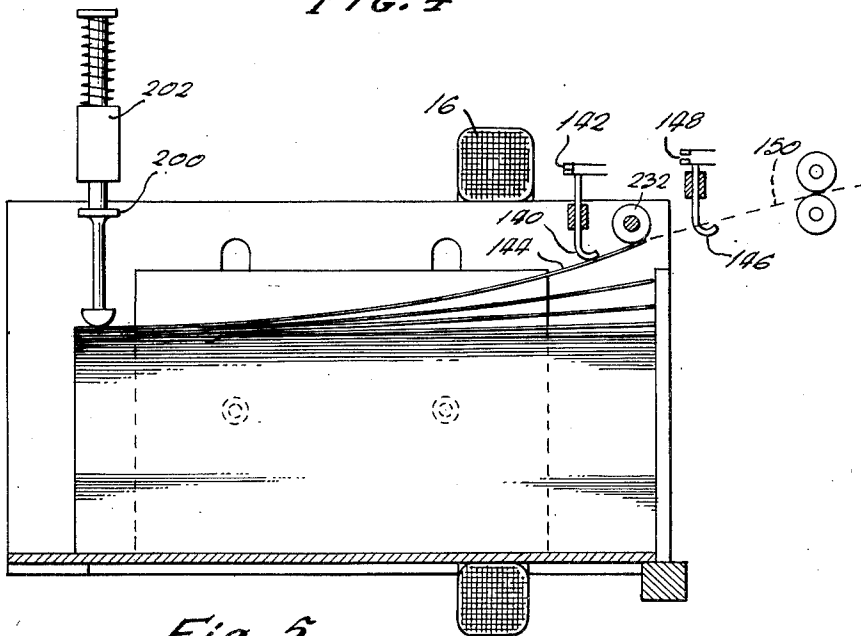


Fig. 5

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FIG. 6

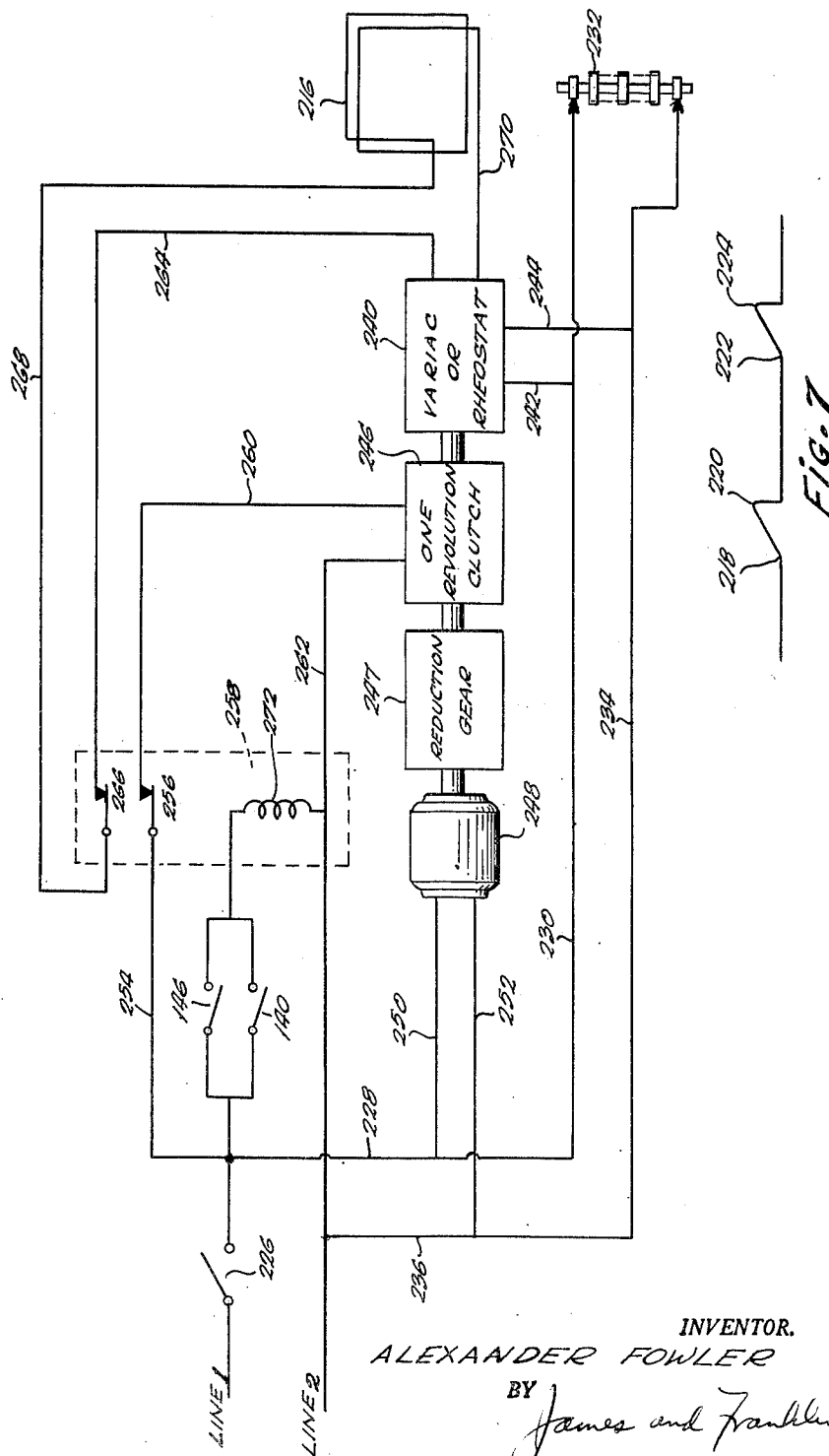


FIG. 7

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UNITED STATES PATENT OFFICE

2,650,824

FEEDING OF MAGNETIC SHEET MATERIAL

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Application November 26, 1949, Serial No. 129,662

24 Claims. (Cl. 271-18)

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This invention relates to the feeding of sheet material, and more particularly to the automatic separation and feeding of single sheets in succession from a stack of ferromagnetic sheets.

Magnetized bodies of like polarity repel, and it has already been proposed to make use of this fact for the separation of the successive topmost sheets from a stack of sheet metal. The idea is applicable to any ferromagnetic material, but in present day commercial practice the common material for which it is suggested is ferrous metal. Prior attempts have been unsuccessful for various reasons, such as inability to produce a strong magnetic field within the sheets in proper direction, or because of variations in the thickness, permeability, or stiffness of the sheet material. The prior systems were not readily adjustable to sheets of different area or size, or of different gauge, and were inherently slow and unreliable in operation.

The primary object of the present invention is to generally improve magnetic sheet separation and feeding apparatus. A more particular object is to produce a wide separation of the sheets magnetically, which will make it possible to feed the uppermost sheet from the stack without necessitating the use of auxiliary supporting means such as suction cups or other such mechanical means. A more particular object is to produce a magnetic flux field which extends longitudinally of the sheets, and preferably throughout the entire length of the sheets. From another viewpoint it may be said that an object of the invention is to use the stack of sheets itself as a massive core through which the magnetic flux field is passed, the flux returning in opposite direction outside the stack. This has the advantage of dispensing with the need for outside cores, and the more important advantage that the natural flux path diverges or fans out at the ends of the stack, thus facilitating the desired wide separation or fanning out of the sheets.

With these objects in view the apparatus includes a large induction coil having generally rectangular windings so dimensioned as to entirely surround the stack of sheets being operated on, the axis of said coil extending longitudinally of the sheets, that is, in the direction in which the sheets are to be fed from the stack.

A further object of the invention is to provide suitable means for feeding the topmost sheet from the stack. For this I provide a magnetic feed roller above the leading end of the sheet at such a height that when power is applied to

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the main induction coil the top sheet flies upward into contact with the feed roller. Appropriate switch means are provided so that the main induction coil is energized while the roller is stationary, and is de-energized while the roller is rotated. The de-energization of the induction coil frees the top sheet for feed movement, and releases the subjacent sheets, permitting them to fall back on the stack. In addition there is a saving of power.

A further object of the invention is to provide means for alternate energization of the main induction coil, and rotative drive of the feed roller. With this object in view the apparatus is preferably provided with a feeler so disposed as to be moved by the topmost sheet when that sheet is raised far enough to reach the feed roller. The feeler may take the form of a suitably positioned microswitch, and operation of the microswitch may start drive of the feed roller, as, for example, by engaging a magnetic clutch which is located between a constantly running motor and the feed roller. The microswitch also is used to de-energize the main induction coil. When the sheet has been fed out of the stack the feeler responds to the passage of the sheet and may be used to re-energize the main induction coil and to stop the drive of the feed roller.

If this is done too promptly the leading edge of the next sheet may be raised into engagement with the trailing edge of the preceding sheet, and thus cause trouble. In accordance with a further feature and object of the present invention this possibility is overcome in any of a number of ways, one being to include a time delay relay in the circuit, which delays re-energization of the main induction coil long enough to insure passage of the trailing edge of the preceding sheet. Another is to provide a second feeler and switch beyond the stack and the feed roller, and to so connect the switch in circuit with the first feeler switch that the main induction coil is not re-energized until the trailing edge of the preceding sheet passes the second as well as the first feeler switch.

A further object of the invention is to guard against the possibility of more than one sheet adhering to the feed roller. This object may be fulfilled in a number of different ways, some of which are described in the detailed specification. One is to energize an electro-magnetic feed roller with two different degrees of energization. The feed roller is first energized only limitedly in order to hold but one sheet, while the feed roller is stationary. It is energized much more strongly,

however, after the main induction coil is deenergized and while the feed roller is rotated, in order to guard against slippage at the feed roller. In some cases this arrangement may be further refined with the provision of three stages of energization of the feed roller, the first stage being strong enough to surely hold the topmost sheet even though it strike the roller somewhat forcibly with a tendency to rebound. In consequence the roller may possibly hold two sheets instead of one. The second stage of energization is the weakest stage, applied after the main induction coil has been de-energized, and is adequate to hold only one sheet under static conditions. The third stage is a strong energization of the feed roller, applied while the feed roller is rotated.

However, the object of insuring the feeding of only a single sheet at a time may be fulfilled in wholly different fashion by energizing the main induction coil with a slowly growing current (or one tooth of a low speed saw-tooth wave). In such case the topmost sheet begins to separate ahead of the next subjacent sheet, and so on, and there is a relatively wide and individual separation of the sheets as the topmost sheet reaches the feed roller. The feed roller may be uniformly strongly energized at all times, and may be made of permanently magnetic material. When the top most sheet reaches the feed roller the energization of the main induction coil is terminated, and the topmost sheet is promptly fed from the stack. This subject matter is not claimed herein, it being claimed in my copending application Serial No. 226,856, filed May 16, 1951, which application is a continuation-in-part of the present application.

When dealing with thin, light-weight sheets there may be a tendency for the sheet to be pulled forward by the main induction coil when the coil is energized. This results from a solenoid action by the coil on the sheet when the coil is disposed near the forward end of the stack. An object of the present invention is to overcome this difficulty, which may be done by the provision of a back induction coil which is preferably disposed in symmetrical relation to the main induction coil, and in the same electrical circuit for energization simultaneously therewith. Another method is to provide a hold-down foot which bears down on and holds the trailing edge of the topmost sheet during energization of the main induction coil. Still another plan is to employ only one main induction coil, but to locate the same at the center of the stack so that there is no tendency to pull the sheets either forward or backward.

To accomplish the foregoing general objects, and other more particular objects which will hereinafter appear, my invention resides in the sheet separating and feeding 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 and feeding 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 a schematic wiring diagram explanatory of one form of the invention;

Fig. 4 is a section similar to Fig. 2 schematically illustrating a modification;

Fig. 5 is a similar section showing still another modification;

Fig. 6 is a schematic diagram explanatory of still another modification of the invention; and

Fig. 7 is explanatory of a current growth curve or saw-tooth wave used in connection with the form of the invention shown in Fig. 6.

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, and which acts as a sheet separating means. 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 feed means generally designated 20 for feeding the uppermost sheet 22 through the coil 16 and away from the stack 14. The feed means 20 preferably includes an electro-magnetic roller 24 capable of feeding sheet 22 with the latter disposed beneath the roller. The roller is preferably intermittently driven, as by means of a magnetic clutch 26 disposed between the roller and a constantly rotating 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, which are preferably made of non-magnetic material. The table 12, on the other hand, is preferably made of ferrous or magnetic material in order to repel and raise even the last sheet of the stack.

If desired the table 12 may be of the elevator type, that is, it may be provided with suitable means to gradually raise the same as the height of the stack is reduced, thus keeping the spacing between the top of the stack and the feed roller substantially constant. Mechanism for this purpose is not shown, in order not to unduly complicate the drawing. Such mechanism is already known, an example being that disclosed in U. S. Patent No. 1,870,314, issued to E. S. Lincoln on August 9, 1932.

Before referring to the wiring diagram, attention is directed to the slip rings 38 (Fig. 1) and brushes 40 which supply magnetizing current to the coils 42 of the feed roller 24. Also the feeler 44 (Fig. 2) controlling switch contacts 46. When the top most sheet 22 reaches the feed roller 24 the feeler is moved from the broken line position 44' to the solid line position 44, thus closing the normally open contacts 46. It will be understood that the showing in Fig. 2 is merely schematic, and that in practice a fully enclosed and sensitive microswitch may be used for the intended purpose. Moreover, other means to discriminate between the absence or presence of a sheet may be used.

Reference is now made to Fig. 3, which is a wiring diagram of one form of the invention. The main induction coil 16, the feed roller 24, the magnetic clutch 26, the motor 28, and the feeler switch or microswitch 46, all correspond to the similarly numbered parts already referred to in Figs. 1 and 2. While not essential, it is preferred to energize the induction coil 16 and the feed roller 24 by means of direct current, and inasmuch as an alternating current supply is more commonly available, as is indicated by lines 1 and 2 at the left end of the diagram, rectifier means 48 is provided for the induction coil 16, and rectifier means 50 is provided for the feed

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roller 24. These are preferably of the full-wave type as shown.

The table is stacked with metal sheets to proper height. A main power switch 52 controls the overall energization of the circuit, and is first closed. The feeler switch or microswitch 46 preferably operates through a relay indicated at 54. This is of the single pole double throw type, and is normally closed to the upper contact 56. To insure complete delivery of a preceding sheet out of the apparatus before re-energization of the main induction coil 16, a time delay relay 58 is provided. The coil 60 of this relay is energized through the upper or normally closed contact 56 of relay 54, thus closing the relay 58 and supplying power to the coil 62 of an auxiliary relay 64. Relay 64 is merely a power relay to carry the power supply to rectifier 48 and main induction coil 16. Thus closing the main power switch 52 energizes the main induction coil 16, after a brief delay, say one second, occasioned by the time delay relay 58.

The operation of the bridge-type rectifier 48 is self-evident from the drawing. The variable resistor 66 is suitably adjusted to establish the desired energization of the main induction coil 16, and when once adjusted need not be varied so long as sheets of the same size, gauge, and material are being handled. The power return from the induction coil 16 is through conductor 68, rectifier 48, and conductor 70 to line 2 of the power supply.

Upon energization of the induction coil 16 the top sheet flies up to the feed roller 24, which is then stationary. As the sheet reaches the feed roller it closes the contacts of the microswitch 46 and so energizes its relay 54, thus closing the same to the lower contact 72, and opening the upper contact 56. This de-energizes the time delay relay 58, thus de-energizing its auxiliary or booster relay 64, which in turn de-energizes the main induction coil 16. The closing of the lower contact 72 of relay 54 energizes the coil 74 of a relay 76, and the coil 78 of a relay 80. It also supplies current through conductor 82 to rectifier 50 and thence through conductor 84 to the magnetizing coils of the feed roller 24. The return circuit is through conductor 86 and conductors 88 and 90 in parallel. Considering conductor 88 first, the circuit continues through adjustable resistor 92, rectifier 50, conductor 94, and conductor 96, back to line 2 of the input or supply source. The resistor 92 is so adjusted relative to the weight of the sheet being handled as to just hold the topmost sheet under static conditions.

The shunt or additional return path from conductor 86 is through conductor 90, adjustable resistor 98, the contacts of relay 80, conductor 100, conductor 102, the rectifier 50, and thence through conductors 94 and 96 to line 2. The adjustable resistor 98 provides a path in shunt with the adjustable resistor 92, and so strengthens the magnetization of the feed rollers 24. The magnetic attraction is made slightly greater than needed for static conditions, for the topmost sheet may hit the roller with some force and tend to rebound. Consequently the increased magnetic attraction of the roller may occasionally support two sheets instead of one. However, the remaining sheets fall because of the de-energization of the main induction coil 16.

The relay 80 is a time delay relay set for a brief interval, say one second, following which its contacts open, thereby opening the shunt re-

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sistor circuit through resistor 98. At this time the magnetization of the feed roller is solely through the resistor 92, and as previously explained, during this second period the magnetization of the feed roller is reduced to an amount just sufficient to hold only the topmost sheet under static conditions. In the event that the feed roller happens to be holding more than one sheet, the additional sheet or sheets are instantly dropped to the stack. After a suitable momentary interval, say one second at most, after relay 80 has opened the contacts 104 of the time delay relay 76 close. This supplies power directly from line 1 through contact 72, conductor 106, contacts 104, conductor 108, to coil 110 of a relay 112, and also to coil 114 of a relay 116. The resulting closing of the contacts of relay 112 serves to shunt the resistor 92 and thus to provide full power magnetization of the feed roller 24. In other words, the return path from the feed roller is through conductor 86, the contacts of relay 112, conductor 102, rectifier 50, and conductors 94 and 96 to line 2 of the power supply.

At the same time the energization of relay 116 causes its contacts to close, thereby supplying power to the electrically operated clutch 26. The energization of the clutch is from line 1 through contacts 72 of relay 54, conductor 106, contacts 104 of relay 76, conductor 108, and conductor 118 to the clutch 26. This may be a magnetic clutch, but that is not essential as any electrically-operated clutch will do. The return circuit from the clutch is through conductor 120, conductor 122, and conductor 96 to line 2 of the power supply.

Thus the sheet is fed forward, the feed roller being subjected to its most powerful magnetization and being set into rotation at the same time, all but the topmost sheet having been safely dropped back to the top of the stack.

When the trailing edge of the sheet moves past the feeler or microswitch 46 the microswitch opens, thus deenergizing the relay 54 and so restoring the parts to initial condition, that is, de-energizing the clutch 26 and so stopping the drive of the feed roller; reducing the energization of the feed roller to the relatively small or first stage energization; and again energizing the time delay relay 58. This provides adequate delay to insure passage of the trailing edge of the sheet wholly out of the apparatus (under drive of later rollers such as 25 in Figs. 1 and 2) before the main induction coil 16 is re-energized. The delay needed is quite small, say one second, at the end of which time the relay 58 closes, thus closing the auxiliary or booster relay, and so re-energizing the main induction coil 16, and thus causing a new sheet to fly upward to the feed roller and to engage the feeler or microswitch 46, all as was previously described.

It may be mentioned that the intervals of approximately one second each referred to above are on the liberal side, and contemplate moderate speed operation using ordinary relays. However, for high speed operation the intervals may be reduced, and electronic relays or vacuum tubes may be employed for extremely high speed operation.

It is preferred to use rectifiers (or a direct current supply) for the main induction coil because with direct current the amount of flux remains substantially constant per unit of area or per sheet, regardless of whether one is starting with

a full stack of sheets, or finishing with the last few sheets. With alternating current there is a change in reluctance when the size of the core is substantially changed, and consequently an undesired change in current, and in flux density in the sheets. However, this assumes that a constant separating force is wanted, which is strictly true only when an elevator table is employed. If the table is stationary it is necessary to raise the top most sheet a greater distance near the end of the stack than near the beginning, and a greater separating force may be wanted, and in such case the use of alternating current would have the advantage of providing a greater separating force when the stack is small than when the stack is large.

In the case of the feed roller direct current is preferred because with direct current the feed roller is more efficient; there is no tendency toward vibration of the sheet in contact with the feed roller; and the grip of the feed roller on the sheet is constant, with no tendency toward intermittent slippage as the feed roller is rotated. However, it is possible to use alternating current instead of direct current if desired.

It should be understood that the arrangement of Fig. 3 may be simplified in other ways in addition to the elimination of the rectifier bridge circuits. An example is that the feed roller may be magnetized in two stages instead of three. For that purpose it is necessary merely to omit the shunt resistor 98 and its control relay 80, in which case the feed roller will be only limitedly magnetized when the resistor 92 is in circuit, and will be strongly magnetized to avoid slippage during feeding of the sheet when the resistor 92 is bypassed. The adjustment of resistor 92 might in such case be slightly different in order to provide a slightly stronger magnetization than is the case when using three stages of magnetization as previously described. The reference to two or three stages means stages of magnetization, for there is also a zero stage, when the feed roll is not energized at all.

In Fig. 3 reference may be made to the manually operable switches 130 and 132. As so far described, these remain in the lower or solid line position shown in the diagram. They are single pole double throw switches and may be provided for convenience in testing the apparatus. For instance, the switch 130, if moved upward, will provide power supply to the main induction coil 16 while the main control switch 52 is open, thus cutting out all of the other parts of the apparatus. Similarly, the switch 132 may be moved manually from its normally lower position to the upper position shown in dotted lines, thus providing power supply for testing and suitably adjusting the magnetization of the feed roller 24, while the rest of the apparatus is cut out of circuit by opening the main control switch 52.

However, switch 132 may be left in its upper position, thus modifying the energization of the feed roller, so that it is energized and attracts and so helps lift the top sheet upward while the main induction coil is energized to raise the upper sheets toward the magnetically energized feed roller. The feed roller then has three instead of four conditions, that is, it has medium, low, and high energization, instead of zero, medium, low and high energization, as previously described.

Before leaving Fig. 3 attention is called to normally closed microswitch 29. This guards against the feed of multiple sheets. If multiple sheets are fed instead of only one sheet, the micro-

switch 29 is opened, and the clutch 26 is disengaged, thereby interrupting the feed of the sheets.

The switch 29 may be arranged for actuation by multiple sheets in various ways. One such way is shown schematically in Fig. 2, reverting to which it will be seen that the switch 29 is a microswitch the feeler of which bears against the top roll. In practice it really bears against a vertically movable bearing thereof. If more than one sheet reaches the roll 25 the microswitch feeler is raised and the switch opened. In practice the switch may be arranged to work through a relay of adequate current carrying capacity for the clutch control current.

In the apparatus shown in Figs. 1 and 2 the main induction coil 16 is disposed near the forward end of the stack. When dealing with thin, light-weight sheets, say no more than 6 oz. in weight, there will be a tendency for the sheets to move forward as they are raised. This will be evident if the main induction coil 16 is considered to be a solenoid coil, it being evident that the sheet will act as a solenoid plunger and thus tend to move forward. To avoid this the coil 16 may be disposed symmetrically or at the centerline of the stack, instead of near the forward end. However, this may introduce a difficulty in that the sheet may tend to tip or balance in either direction. Another way to solve the problem is schematically shown in Fig. 4, in which it will be seen that in addition to the first or main induction coil 16, a second induction coil 134 is provided, the latter being disposed near the back end of the stack, and preferably symmetrically disposed with relation to the coil 16. No separate wiring diagram is shown for this modification of the invention because coils 16 and 134 are energized and de-energized simultaneously. For this purpose the coils may be connected either in shunt or in series. Thus the diagram of Fig. 3 is adequate, it being kept in mind that the coil 16 there shown is to be replaced by two coils arranged either in shunt or in series. The coil 134 will tend to cause the rear end 136 of the topmost sheet 138 to rise at the same time as the forward end, but that is not its purpose. Coil 134 is to be thought of as a hold-back coil, the purpose of which is to guard against forward movement of the sheet 138 under the influence of the coil 16. When the sheet engages the feeler 44 and the magnetic feed roller 24 both coils 16 and 134 are de-energized, thus permitting the rear end 136 of sheet 138, as well as the subjacent sheets, to fall back to the stack, the forward end of the sheet being retained by the feed roller 24.

Fig. 5 illustrates another modification in the provision of a normally raised hold-down foot 200 for use with thin, light-weight sheets. Hold-down foot 200 may be urged downwardly by suitable means 202 responsive to electrical power, or compressed air, or any other suitable source of power which may be conveniently available. If the pressure foot 200 is solenoid operated the means 202 will comprise essentially a solenoid coil connected either in shunt or in series with the main induction coil 16, thus holding back the topmost sheet coincidentally with the energization of induction coil 16. When the feed roller 24 moves the sheet the main induction coil 16 is de-energized, and solenoid 202 is de-energized along with it, thus releasing the sheet for forward feed. If the pressure foot 200 is operated by compressed air the air supply to the air cylinder is preferably controlled by a

suitable solenoid operated air valve, the latter in turn being so connected in circuit with the main induction coil 16 as to make the pressure foot operative whenever the main induction coil is energized, and inoperative when it is not.

It will be recalled that the wiring diagram of Fig. 3 included a time delay (the relay 58) to delay re-energization of the main induction coil until the trailing edge of a preceding sheet has safely left the magnetic feed roller 24. This avoids any possibility of the next top sheet being caused to fly upward prematurely, in which case the forward portion of said sheet may strike the bottom of the trailing portion of the preceding sheet, thus holding it back both physically and magnetically, or, in the alternative, causing the second sheet to be prematurely pulled forward by the first sheet. This result may be accomplished by using a second feeler instead of a time delay relay, and such an arrangement is schematically shown in Fig. 5 in which it will be seen that most of the parts, including the main induction coil 16 and magnetic feed roller 232, correspond to those previously described. However, the first feeler 140 closes contacts 142 when engaged by the topmost sheet 144, and a second feeler 146 is provided outside the stack, said feeler serving to close contacts 148 when engaged by a sheet 150 passing through feed rollers 152. This is described further as an incident to the description of Fig. 6 which follows.

Fig. 6 schematically illustrates another form of my invention. The main feature of this arrangement is that the induction coil 216 is energized by a gradually increasing current which starts at zero and rises to a desired value. Thus the current may follow an intermittent saw-tooth wave such as that illustrated in Fig. 7. In Fig. 7 it will be seen that the current rises from the point 218 to a maximum at 220, whereupon it is cut off and remains off until the point 222. The interval between points 220 and 222 corresponds to the time during which the sheet is fed away from the stack by the feed roller. When the main induction coil 16 is re-energized beginning at point 222 the current again increases to a maximum as indicated at 224 and is again cut off.

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. Indeed, by promptly de-energizing the induction coil when the topmost sheet reaches the feed roller it is found that the feed roller may be left at full energization, and further that it may be kept under constant rotation. Thus the apparatus of Fig. 6 is more complicated than that previously described in introducing suitable means to apply a growth current or saw-tooth current to the induction coil, but is simplified in eliminating the time delay relays and adjustable resistors and electrically operated clutch for the feed roller.

Referring to Fig. 6, a main power switch 226 is closed to supply power from an ordinary source indicated by lines 1 and 2. This supplies power through conductors 228 and 230 to feed roller

232, the return being through conductors 234 and 236 to line 2. The power supply to the induction coil 216 is varied by means of a suitable variable impedance 240. If the power supply is alternating current this may be either a conventional "Variac" or a rheostat. "Variac" is a trade name of the General Radio Company for a variable voltage transformer (disclosed in Patent #2,009,013). It is a device which increases or decreases voltage by mechanical rotation of a contact engaging the windings of a transformer. If the power supply is direct current the variable impedance would, of course, be a rheostat. The power supply to the Variac 240 is from line 1 through conductors 228, 230 and 242, the return being through conductors 244, 234, and 236 and back to line 2.

The Variac 240 is driven through a one-revolution clutch 246 and reduction gearing 247 by means of a motor 248 energized from the power line through conductors 250 and 252. One-revolution clutch 246 is electrically operated, and is initially engaged because of a supply of power from line 1 through conductor 254, normally closed contacts 256 of relay 258, and a conductor 260. The return is through a conductor 262 to line 2. The resulting rotation of the Variac causes a growth in output current from zero until the one-revolution clutch disengages. The power available in this way for the main induction coil 216 could grow to a value greater than needed to raise the first sheet into engagement with the feed roller, but the power supply is interrupted by suitable means as soon as the sheet reaches the feed roller. The mechanical rotation of the Variac is continued under drive of motor 248, and is terminated after one revolution by the operation of the one-revolution clutch, thus preparing the apparatus for the separation and delivery of the next sheet.

In the meantime the growing current is supplied from the Variac through conductor 264, the normally closed contacts 266 of relay 258, and conductor 268 to the induction coil 216, the return being through conductor 270.

In the present apparatus the complete passage of a sheet is determined by the use of two feelers as shown in Fig. 5, instead of a single feeler combined with a time delay relay as shown in Fig. 2, although either arrangement might be used. The first and second feelers or microswitches are indicated at 140 and 146. The contacts are normally open. When the topmost sheet flies upward and reaches the feed roller it closes the switch 140, thus energizing relay coil 272 and so opening the contacts 266 and thereby interrupting the energization of the induction coil. This drops all sheets but the uppermost sheet, the latter being held by the fully magnetized feed roller, which may be constantly rotated and which promptly begins feeding the sheet out of the stack. In this case the feed roller may be permanently magnetized, as by making the same of Alnico or other highly magnetic material. However, as here shown it is magnetized electrically, with a constant current supply.

Energization of relay 258 opens the contacts 256 and thus de-energizes the electrically controlled clutch 246 so that when it disengages at the end of a single revolution it will not again engage unless and until the preceding sheet has been fed entirely out of the apparatus.

When the trailing edge of the sheet leaves the feeler 140 the relay coil 272 is not yet de-energized because of the action of the feeler 146, and there-

fore the main induction coil is not yet re-energized. However, when the trailing edge of the sheet leaves the second feeler 146 the relay coil 272 is de-energized, the contacts 256 and 266 are again closed, and the induction coil is again energized to raise another sheet to the feed roller.

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 several preferred forms, changes may be made in the structures disclosed without departing from the scope of the invention as sought to be defined in the following claims.

I claim:

1. Apparatus for separating and successively feeding ferromagnetic sheets from a stack of sheets, said apparatus comprising a support for the stack of sheets, an induction coil extending entirely around the stack of sheets, with the axis of the coil extending generally in the direction of the plane of the sheets and generally perpendicular to the desired direction of separation of the sheets, means to energize the coil in order to raise and separate the uppermost sheets of the stack, and feed means to receive and feed the uppermost sheet away from the coil and stack.

2. Apparatus for separating and successively feeding ferrous sheets from a stack of sheets, said apparatus comprising a support for the stack of sheets, an induction coil extending entirely around the stack of sheets, with the axis of the coil extending in the direction of the plane of the sheets and generally perpendicular to the desired direction of separation of the sheets, means to energize the coil in order to raise and separate the uppermost sheets of the stack, and a magnetic feed roller to feed the uppermost sheet away from the coil and stack.

3. Apparatus for separating and successively feeding ferromagnetic sheets from a stack of sheets, said apparatus comprising a support for the stack of sheets, an induction coil extending entirely around the stack of sheets, a sheet feeding means disposed near the leading end of the stack, drive means for intermittently driving the feed means, means to energize the induction coil in order to raise and separate the uppermost sheet of the stack and to bring it to the feed means, and appropriate switch means for the induction coil interlocked with the drive means whereby the induction coil is energized while the feed means is inoperative and is de-energized while the feed means is operative.

4. Apparatus for separating and successively feeding ferrous sheets from a stack of sheets, said apparatus comprising a support for the stack of sheets, an induction coil extending entirely around the stack of sheets, with the axis of the coil extending in the direction in which the sheets are to be fed, a magnetic feed roller disposed over the leading end of the stack, drive means for intermittently driving the roller, means to energize the coil in order to raise and separate the uppermost sheet of the stack and to bring it to the feed roller, and appropriate switch means for the induction coil interlocked with the drive means whereby the induction coil is energized while the roller is stationary and is de-energized while the roller is rotated.

5. Apparatus for separating and successively feeding ferromagnetic sheets from a stack of sheets, said apparatus comprising a support for

the stack of sheets, a main induction winding extending entirely around the stack of sheets, a magnetic roller having a magnetizing coil, intermittently operable drive means for intermittently rotating the roller, means to energize the main induction winding in order to raise and separate the uppermost sheet of the stack and to bring it to the roller, means for supplying current to said coil, means to energize the coil to only a limited extent sufficient to hold the uppermost sheet when the feed roller is not rotating, means to more strongly energize the coil in order to feed the sheet without appreciable slippage when the roller is rotated, and appropriate switch means to energize the main induction winding when the feed roller is stationary, and to de-energize the main induction winding when the feed roller is rotating.

6. Apparatus for separating and successively feeding ferrous sheets from a stack of sheets, said apparatus comprising a support for the stack of sheets, a main induction winding extending entirely around the stack of sheets, with the axis of the winding extending in the direction in which the sheets are to be fed, a magnetic roller having magnetizing coils distributed therealong, intermittently operable drive means for intermittently rotating the roller, slip rings for supplying current to said coils, means to energize the main induction winding in order to raise and separate the uppermost sheet of the stack and to bring it to the roller, means to energize the coils to only a limited extent sufficient to hold the uppermost sheet when the feed roller is not rotating, means to more strongly energize the coils in order to feed the sheet without appreciable slippage when the roller is rotated, and appropriate switch means to energize the main induction winding when the feed roller is stationary, and to de-energize the main induction winding when the feed roller is rotating.

7. The combination of claim 3, in which a feeler is disposed above the stack at such a height that it is moved by the uppermost sheet when the uppermost sheet has been raised to the feed means, said feeler serving to operate the aforesaid switch means.

8. The combination of claim 5, in which a feeler is disposed above the stack at such a height that it is moved by the uppermost sheet when the uppermost sheet has been raised to the feed roller, said feeler serving to operate the aforesaid switch means.

9. The combination of claim 3, in which a delay relay is disposed in the circuit to prevent re-energization of the induction coil until after the trailing edge of a preceding topmost sheet has been safely fed beyond the leading edge of the stack.

10. The combination of claim 5, in which a delay relay is disposed in the circuit to prevent re-energization of the main induction winding until after the trailing edge of a preceding topmost sheet has been safely fed beyond the leading edge of the stack.

11. Apparatus as defined in claim 3, in which there are two feelers, one of which is disposed over the stack and is responsive to the presence of a sheet in engagement with the feed roller, and the other of which is disposed ahead of the stack and is responsive to the feeding of a sheet from the stack, and switches controlled by said feelers and so arranged in the circuit as to prevent re-energization of the induction coil until

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after the trailing edge of a preceding topmost sheet has passed both feelers.

12. Apparatus as defined in claim 5, in which there are two feelers, one of which is disposed over the stack and is responsive to the presence of a sheet in engagement with the feed roller, and the other of which is disposed ahead of the stack and is responsive to the feeding of a sheet from the stack, and switches controlled by said feelers and so arranged in the circuit as to prevent re-energization of the main induction winding until after the trailing edge of a preceding topmost sheet has passed both feelers.

13. Apparatus for separating and successively feeding ferromagnetic sheets from a stack of sheets, said apparatus comprising a support for the stack of sheets, an induction coil extending entirely around the stack of sheets, with the axis of the coil extending generally in the direction in which the sheets are to be fed, means to energize the coil in order to raise and separate the uppermost sheets of the stack, feed means to receive the uppermost sheet when raised and to feed it away from the stack, and feeler means responsive to the thickness of the sheet material being fed away from the stack for interrupting operation of the feed means if more than one sheet is being fed.

14. Apparatus for separating and successively feeding ferromagnetic sheets from a stack of sheets, said apparatus comprising a support for the stack of sheets, an induction coil extending entirely around the stack of sheets, means to energize the coil in order to raise and separate the uppermost sheets of the stack, a sheet feeding means disposed near the leading end of the stack to receive the uppermost sheet when raised, drive means for intermittently driving the feed means, appropriate switch means for the induction coil interlocked with the drive means whereby the induction coil is energized while the feed means is inoperative, and the induction coil is de-energized while the feed means is operative, and feeler means responsive to the thickness of the sheet material being fed from the stack for interrupting the operation of the drive means if more than one sheet is being fed.

15. Apparatus for separating and successively feeding ferromagnetic sheets from an upright stack of generally horizontal sheets, said apparatus comprising a support for the stack of sheets, an induction coil disposed in an upright plane and having each of its windings extending entirely around the stack of sheets, with the top of the coil higher than the top of the stack to provide substantial clearance therebetween, and with the axis of the coil extending generally horizontally in the direction in which the sheets are to be fed, means to energize the coil in order to raise and separate the uppermost sheets of the stack, and feed means to receive the uppermost sheet when raised and to feed it in a generally horizontal direction away from the coil and stack.

16. Apparatus for separating and successively feeding ferromagnetic sheets from an upright stack of generally horizontal sheets, said apparatus comprising a support for the stack of sheets, an induction coil disposed in an upright plane and having each of its windings extending entirely around the stacks of sheets, with the top of the coil higher than the top of the stack to provide substantial clearance therebetween, and with the axis of the coil extending generally horizontally in the direction in which the sheets are to be fed, means to energize the coil in order to

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raise and separate the uppermost sheets of the stack, and a magnetic feed roller having a horizontal axis extending across the direction of feed and disposed at a point higher than the stack but lower than the top of the induction coil, said magnetic feed roller serving to receive the uppermost sheet when raised and to feed it in a generally horizontal direction away from the coil and stack.

17. Means for feeding a ferromagnetic sheet, said means including a magnetic sheet feed roller having a magnetizing coil, intermittently operable drive means for intermittently rotating the feed roller, a first supply circuit to energize the coil to only a limited extent, a second supply circuit to more strongly energize the coil, and appropriate automatic means so interconnecting the drive means and said supply circuitry that the coil is supplied by the first circuit when the feed roller is not driven by the drive means, and is supplied by the second circuit when the feed roller is driven by the drive means.

18. Means for feeding the uppermost sheet from a stack of ferrous sheets, said means including a magnetic sheet feed roller disposed above the stack and having magnetizing coils distributed therealong, means to bring the top sheet within the influence of the feed roller, intermittently operable drive means for intermittently rotating the feed roller, a first supply circuit to energize the coil to only a limited extent sufficient to hold the uppermost sheet when the feed roller is not rotating, a second supply circuit to more strongly energize the coils sufficiently to grip and feed the sheet without appreciable slippage when the feed roller is rotating, and appropriate automatic means so interconnecting the drive means and said supply circuitry that the coil is supplied by the first circuit when the feed roller is not driven by the drive means, and is supplied by the second circuit when the feed roller is driven by the drive means.

19. Apparatus for separating ferromagnetic sheets from a stack of sheets, said apparatus comprising a support for the stack of sheets, an induction coil extending entirely around the stack of sheets, with the axis of the coil extending generally in the direction of the plane of the sheets and generally perpendicular to the desired direction of separation of the sheets, and means to energize the coil in order to raise and separate the uppermost sheets of the stack.

20. Apparatus for separating ferromagnetic sheets for removal from an upright stack of generally horizontal sheets, said apparatus comprising a support for the stack of sheets, an induction coil disposed in an upright plane and having each of its windings extending entirely around the stack of sheets, with the top of the coil higher than the top of the stack to provide substantial clearance therebetween, and with the axis of the coil extending generally horizontally in the direction in which the sheets are to be removed, and means to energize the coil in order to raise and separate the uppermost sheets of the stack.

21. Apparatus for separating ferromagnetic sheets from a stack of sheets, said apparatus comprising a support for the stack of sheets, an induction coil disposed with the axis of the coil extending generally in the direction of the plane of the sheets and generally perpendicular to the desired direction of separation of the sheets, said coil being so large in diametral dimension that the sheets may be moved through the induction

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coil in the direction of the axis of the coil, and said coil being disposed so close to the stack that the field of the coil runs through the stack, with the stack acting as a core for the field and coil, and means to energize the coil in order to raise and separate the uppermost sheets of the stack.

22. Apparatus for separating ferromagnetic sheets for removal from an upright stack of generally horizontal sheets, said apparatus comprising a support for the stack of sheets, an induction coil disposed in an upright plane with the top of the coil higher than the top of the stack to provide substantial difference in elevation therebetween and with the axis of the coil extending generally horizontally in the direction in which the sheets are to be removed, said coil being so large in diametral dimension that the sheets may be moved through the coil in the direction of the axis of the coil, and said coil being disposed near enough to the stack so that the field of the coil runs through the stack, with the stack acting as a core for the field and the coil, and means to energize the coil in order to raise and separate the uppermost sheets of the stack.

23. Apparatus for separating and successively feeding ferromagnetic sheets from a stack of sheets, said apparatus comprising a support for the stack of sheets, an induction coil disposed with the axis of the coil extending generally in the direction of the plane of the sheets and generally perpendicular to the desired direction of separation of the sheets, said coil being so large in diametric dimension that the sheets may be pulled through the induction coil in the direction of the axis of the coil, and said coil being disposed so close to the stack that the field of the coil runs through the stack, with the stack acting as a core for the field and coil, means to energize the coil in order to raise and separate the uppermost sheets of the stack, and feed means to receive and feed the uppermost sheet away from the coil and stack.

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24. Apparatus for separating and successively feeding ferromagnetic sheets from an upright stack of generally horizontal sheets, said apparatus comprising a support for the stack of sheets, an induction coil disposed in an upright plane with the top of the coil higher than the top of the stack to provide substantial difference in elevation therebetween and with the axis of the coil extending generally horizontally in the direction in which the sheets are to be fed, said coil being so large in diametric dimension that the sheets may be pulled through the coil in the direction of the axis of the coil, and said coil being disposed near enough to the stack so that the field of the coil runs through the stack and the stack acts as a core for that field and the coil, means to energize the coil in order to raise and separate the uppermost sheets of the stack, and feed means to receive the uppermost sheet when raised and to feed it in a generally horizontal direction away from the coil and stack.

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