

June 21, 1949.

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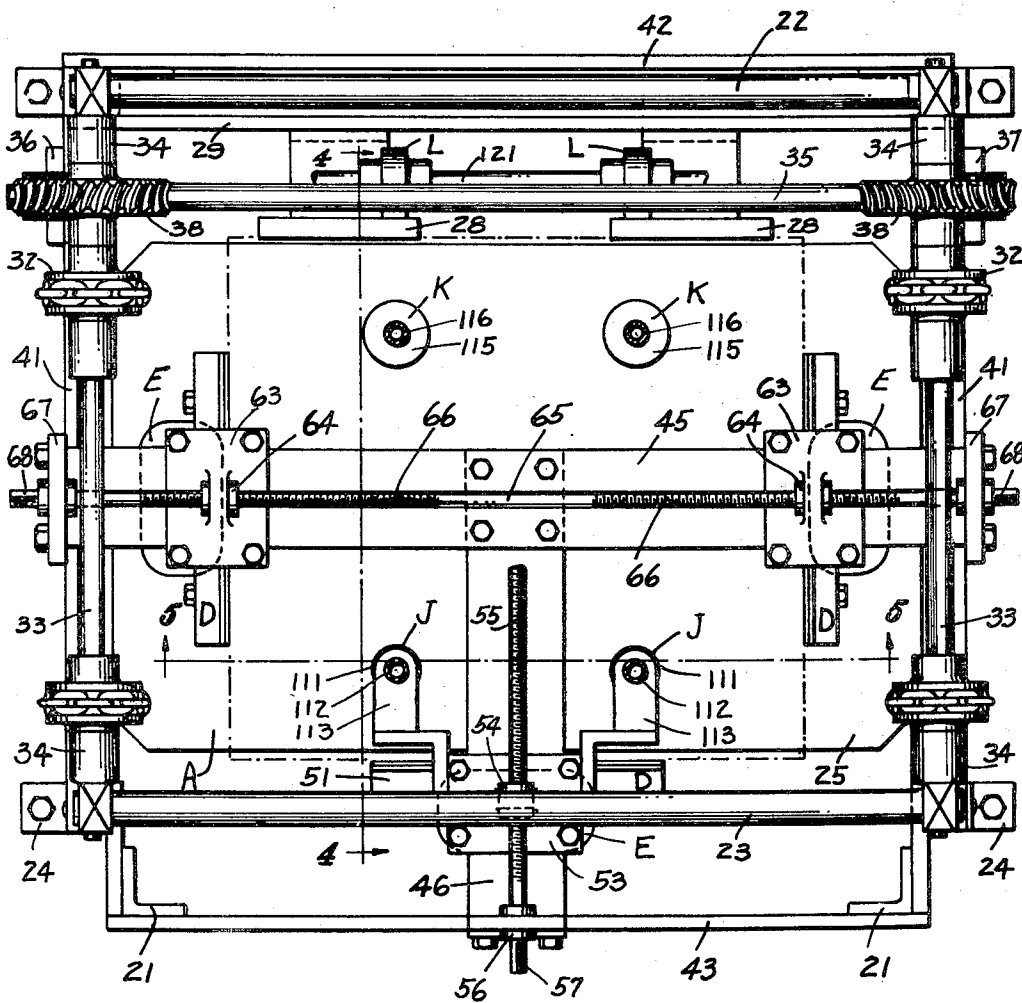
2,474,141

METHOD AND APPARATUS FOR FEEDING SHEETS

Filed Oct. 11, 1945

4 Sheets-Sheet 1

Fig.1



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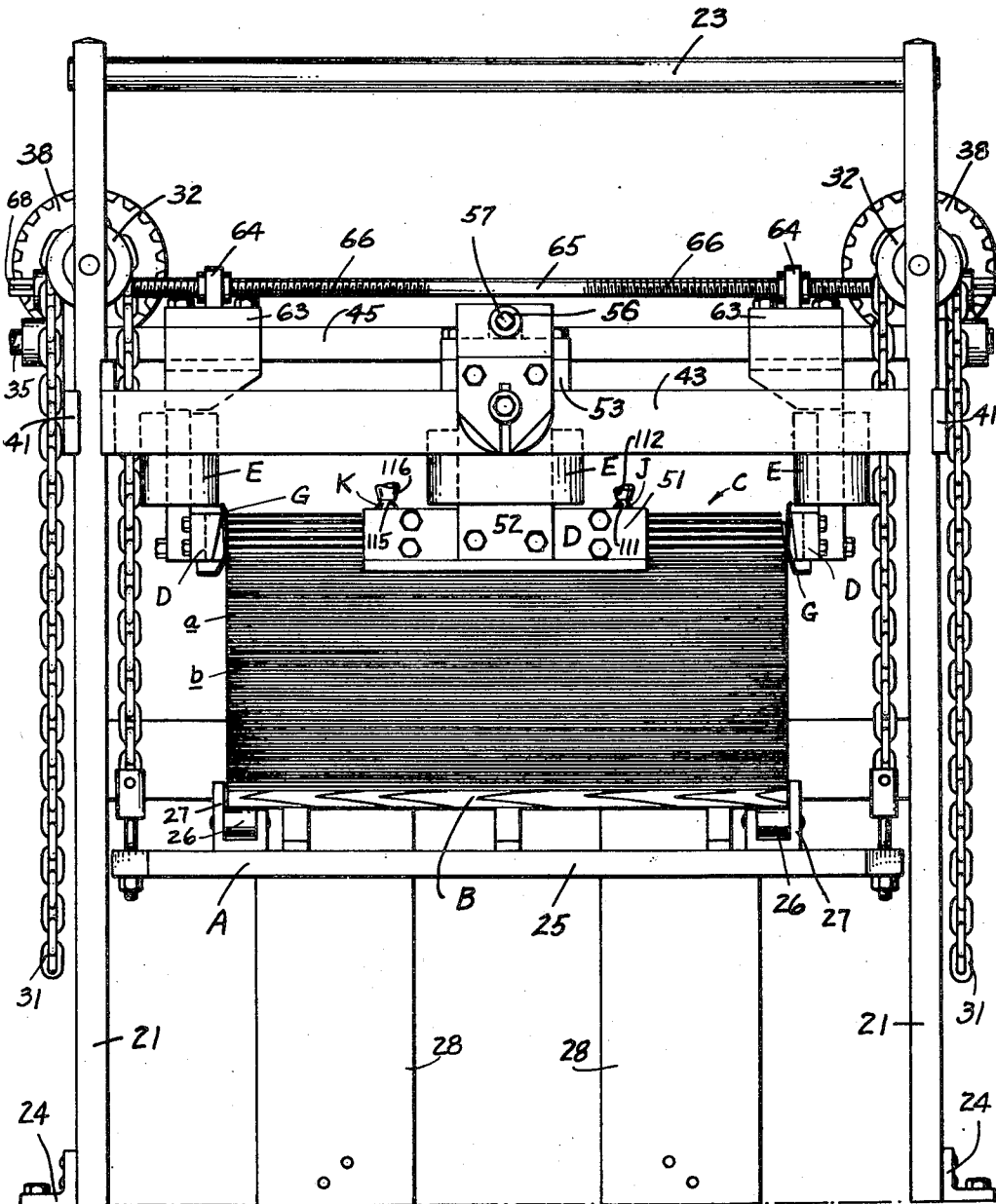
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4 Sheets-Sheet 2

Fig. 2



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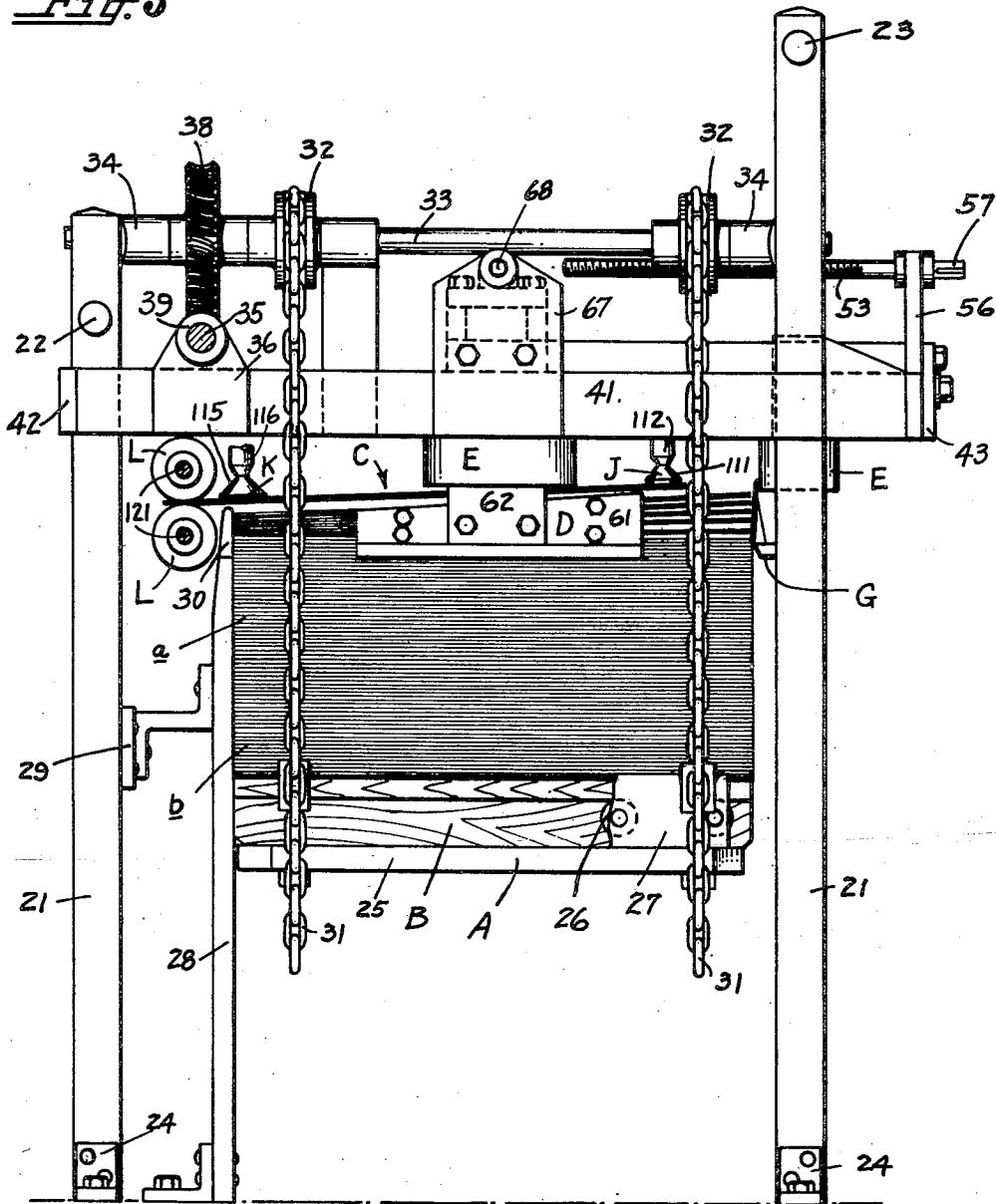
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4 Sheets-Sheet 3

Fig. 3



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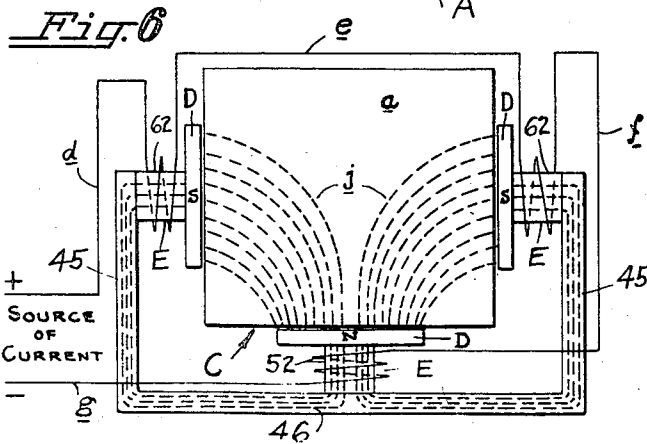
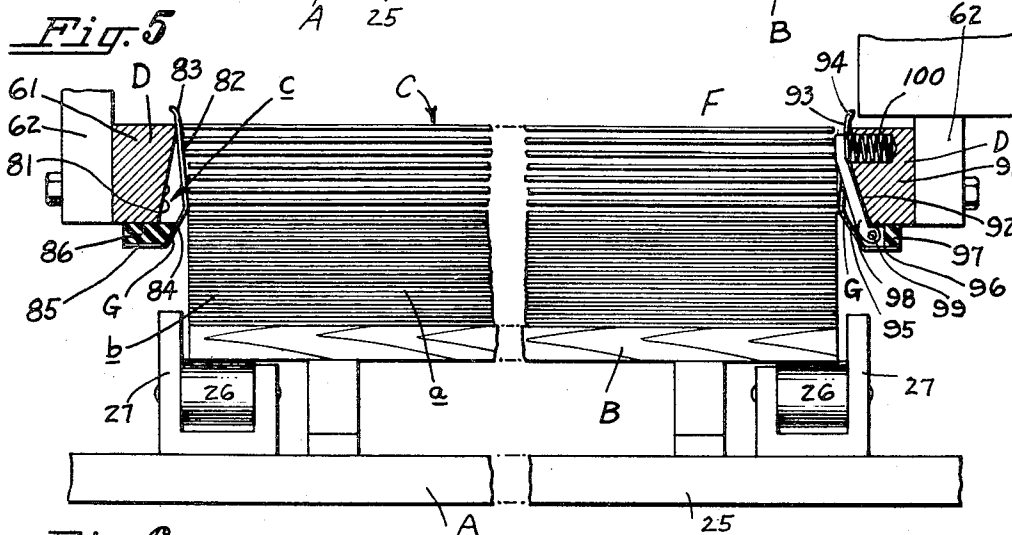
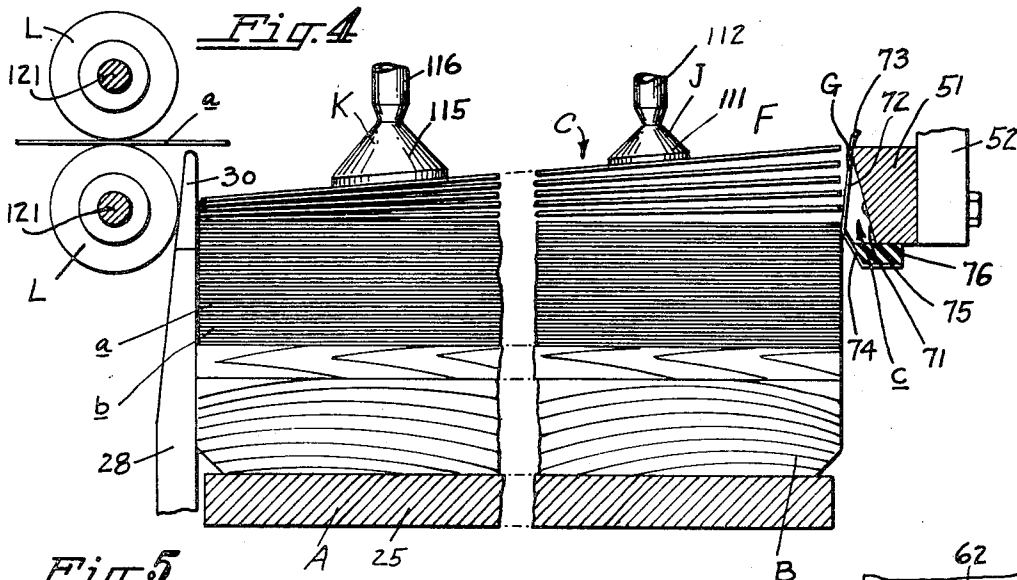
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METHOD AND APPARATUS FOR FEEDING SHEETS

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4 Sheets-Sheet 4



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METHOD AND APPARATUS FOR FEEDING SHEETS

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25 Claims. (Cl. 271-18)

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The present invention relates to the individual feeding of sheets of metal by passage through a magnetic field constituting a zone of separation and has particular reference to a method and apparatus which utilizes a plurality of magnetic areas of different magnetic strengths the nature of the magnetic flux in the areas being such as to cause the sheets to move under magnetic propulsion and in separated relation one to the other, thus insuring the feeding of only a single sheet at one time.

The present invention contemplates the feeding of sheets such as are used in great numbers by can manufacturers preferably from a stack. From the stack the sheets pass through a field or zone comprising a plurality of magnetic areas of separation of different or varying magnetic forces so that a sheet upon entering the area of lesser force becomes magnetized and moves into an area of greater magnetic flux density and this continues progressively the sheet thus passing from area to area. During such passage reluctance gaps are utilized in a manner which separates the sheets one from another while in the separation zone. Being thus definitely separated one from the other only a single sheet is fed after passage through the magnetic areas of the separation zone.

An object of the invention is the provision of a method of and apparatus for feeding sheets one at a time by introduction of the sheets into one of a variety of magnetic areas or strata so that the magnetized sheets when unrestricted pass into the next adjacent field and so on throughout the separation zone, removal of but a single sheet from the magnetic areas thus being assured at all times.

Another object of the invention is the provision of a method of sheet feeding in which reluctance gaps are maintained laterally of the stack of the sheets during their passage through the magnetic areas such reluctance gaps having less flux density than the flux density in the sheets with the result that adjacent sheets do not closely approach each other but are held in separated positions throughout the separation zone.

Yet another object is the provision of a method of sheet feeding in which the magnetic separation field or zone includes a plurality of magnetic areas or strata of uniformly increasing strength from one boundary of the zone to the other, the various areas fanning out one relative to the other so that the weakest magnetic area is always inward of the point of feeding the

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outermost separated sheet and the outermost or strongest magnetic area or stratum is at an angle to said weakest area, thereby insuring that the outermost sheet or the sheet closest to the point of feeding is always in the most suitable position for removal from the magnetic field.

Another object of the invention is the provision of an apparatus for sheet feeding from a stack of magnetizable sheets having spaced magnets for setting off a magnetic field or zone of sheet separation in which there are a plurality of layers of magnetic areas the inner faces or stack facing sides of the magnets being inclined or at an angle to the stack to impart varying strengths of magnetic flux effective in the different magnetic fields.

A further object is the provision of such an apparatus in which magnets are located on three sides of the zone of separation there being opposed side magnets on two of the sides and one or more intermediate magnets on the third side, all of the magnets having their bottom edges in a horizontal plane and the side magnets being wedge shaped or inclined along the top relative to the plane of the unseparated sheets in the stack, this construction imparting a fan shape to the various resulting magnetic areas of strata in the sheet separation zone, each magnetic area being at a slight angle to the area adjacent with the greater thickness of each area in the magnetic zone adjacent the intermediate magnet which assists in supporting the edges of the sheets adjacent it to maintain each sheet in a substantially flat condition so that the topmost sheet in being fed from the zone of separation is sufficiently elevated to clear all other sheets in the separation zone and to avoid striking any machine parts during the removal of the sheet.

Another object of the invention is the provision of a sheet feeding apparatus of the character described in which the sheets are guided between non-magnetic members and all sheets are aligned against one of the members during passage between the guides, the non-magnetic guides also keeping the sheet edges away from the magnets thus setting up the reluctance gaps for each sheet which function to keep the sheets separated while within the separation zone.

Still another object is the provision of a sheet feeding apparatus in which a stack of sheets is gradually lifted on an elevator and the stack is constantly centralized relative to the magnetic areas or strata in the separation zone and sheets on the top of the stack are introduced into the bottom of the zone of separation in synchronism

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with removal of separated sheets from the top with the result that substantially the same number of sheets are held suspended within the separation zone thus imparting high speed uniform sheet feeding action with sure and efficient sheet separation timing.

Numerous other objects and advantages of the invention will be apparent as it is better understood from the following description, which, taken in connection with the accompanying drawings, discloses a preferred embodiment thereof.

Referring to the drawings:

Figure 1 is a plan view of an apparatus for separating sheets of metal for feeding in accordance with the steps of the method and embodying apparatus of the present invention;

Fig. 2 is a rear view of the apparatus illustrating sheets carried on top of a stack passing through a magnetic field or separation zone preparatory to feeding;

Fig. 3 is a side elevation of the apparatus illustrated in Fig. 1 as viewed from the left hand side of that figure;

Fig. 4 is a longitudinal section taken substantially along the line 4—4 in Fig. 1 and drawn to an enlarged scale;

Fig. 5 is an enlarged transverse section taken substantially along the line 5—5 in Fig. 1; and

Fig. 6 is a diagrammatic view showing generally in plan the action of the separation magnets and the magnetic lines of force as effective in the separation zone.

In the drawings of the present invention one type of apparatus is disclosed as being adapted to the feeding of sheets of metal *a* such as tin plate or the like, from a stack *b*. The stack of sheets is preferably deposited upon an elevator *A* (Fig. 2) such a stack being held upon the usual skid or platform *B* used in plants of the can manufacturer. The elevator is designed to gradually and uniformly lift the stack of sheets during the operation of the apparatus.

At the top of the stack there is disposed a space *C* which constitutes the magnetic field or zone of separation. On three sides of this space are positioned magnets *D* for creating the magnetic lines of force within the separation zone *C*.

The magnets, which are preferably electromagnets but may be permanent magnets, are preferably formed with cores or poles of solid block form sufficient in length to extend along a substantial part of three of the edges of the sheets as they are positioned in the stack. In this preferred embodiment the magnet cores are surrounded by magnetic coils *E*. When the coils are energized the magnetic flux flows from the poles of the magnets into the solid load of sheets on the top of the stack *b* and this attracts a number of sheets causing the same to rise within the zone of separation *C*. These sheets position themselves in the magnetic zone in such a manner that each sheet becomes saturated to a certain degree and in this magnetized condition moves through the zone of separation.

The upward movement of the sheets from the stack through the magnetic field or zone of separation when a sheet is removed results from the increased magnetic flux density created in the top portion of the magnetic field just vacated by the removed sheet. The sheet which was just below the removed top sheet, is attracted into this vacated area of increased flux density. This causes an increase in flux density immediately below thereby causing the next lower

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sheet and likewise each succeeding lower sheet to rise in the magnetic zone. The top sheet in the stack *b* of unseparated sheets thus enters the zone by leaving the stack. The result of such action is the maintenance of a substantially constant flux density at all times in the magnetic field.

The final positioning of the sheets in the zone of separation is determined by the inner faces of the magnets being inclined from the vertical. This provides a greater distance for the lines of magnetic flux passing between magnets of opposite polarity with the result that the zone of separation may be considered as consisting of a plurality of areas or strata *F* which have different magnetomotive forces. Obviously since the shorter distance between magnets *D* for the conduction of the magnetic flux is at the top of the zone of operation, the area at the top is at the maximum of magnetomotive force, thereby causing the topmost sheet to always lie substantially in the plane of the top edges of the magnet poles for removal by the feeding means.

The number of sheets which rise in the magnetic field depends on the degree of saturation required to overcome the force of gravity. Provision is also made for preventing the edges of the sheets coming into contact with the faces of the magnets. This is done by means of non-magnetic guides or spacing members *G* which create a number of air gaps *c* (Figs. 4 and 5) between the sheet edges and the magnets. Each sheet absorbs large amounts of flux from the air gap between it and the magnet pole and this causes a centering of the sheet *a* in the magnetic zone *C*.

This air gap *c* between the sheet edge and the magnet is effective as a reluctance gap for each individual sheet and the flux density in the space will be less than that within the sheets. The effect of this is to separate adjacent sheets and to prevent them from approaching too closely together. This therefore provides a definite separation of each individual sheet while it is in the separation zone.

At the time the sheets within the separation zone are rising into successive magnetic areas of greater flux density provision is made for uniformly aligning the sheet edges irrespective of slight differences in dimension of the sheets. This is done by causing all of the sheets to engage against one of the non-magnetic guides *G* at one side of the sheets within the separation zone. The left hand guide *G* as shown in Fig. 2 is the aligning guide of the apparatus shown.

The rear or intermediate magnet *D* which is located along the third side of the sheets within the separation zone is effective in supporting the center of each sheet. In the event that the sheets are of only small dimension such a third magnet may be eliminated but for ordinary sheet feeding as found necessary in a manufacturing plant, a third magnet is utilized to keep the sheets as flat as possible and thus minimize sagging or bending.

Since the fourth sides of the sheets at the edges do not have magnetic separation, these substantially unmagnetized edges will come together. To better support these edges of the sheets the various magnetic areas or strata within the separation zone are so arranged as to be slightly out of parallel. In other words there is a flaring out or fanning out of the various areas. The unmagnetized edges of the sheets may rest on the unseparated sheets in the stack below

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the zone of separation C. Fig. 4 shows this position. Off-center or at the sides of these edges, the sheets may be slightly separated by the side magnets.

In order to accomplish this fanning out of the sheets, the side magnets, which it will be recalled, are disposed opposite one another along the two sides of the sheet, are wedge shaped. This means that the top surfaces of the magnets are in an inclined plane (Fig. 3). All of the magnets at the bottom are in the same horizontal plane. Thus it will be seen that by reason of the resulting wedge shape with its inclined upper surfaces of the two side magnets, that the topmost magnetic area and the adjacent areas below are at an angle to the horizontal.

The high side of the topmost area is located along the intermediate magnet. All of the intervening magnetic areas between the top area and the bottom are fanned out. This follows, by reason of the inclined inner faces of the magnets forming the air gaps c. The strongest air gaps are at the top and the bottom or lowermost air gap is the weakest. Since three edges of each separated sheet are supported by the magnetic field, and the fourth edge is held virtually flat by reason of its contact with the sheet immediately beneath, the whole sheet is maintained in a substantially flat or unbowled position. It is important that the separated sheets be flat, since if they are not, they flatten out when engaged and lifted by feeding devices such as suction cups, and thus strike against the non-magnetic guides.

In order to further separate the rear edge of the topmost sheet from the rear edge of the sheet directly beneath at the time of removing a sheet from the zone and also to elevate the sheet slightly above the rear magnet as it is being fed, supplemental lifting devices J (Figs. 1 and 3) are used. These devices may take the form of suction cups which is the embodiment shown in the drawing and described in the specification. This further lifting of the rear edge of the topmost sheet takes place just prior to removal of the sheet from the zone of separation C. This insures against any engagement of adjacent sheets and insures against the topmost sheet striking the machine parts at the time it is being fed. This is particularly useful where the sheets have been lithographed, as a lithographed surface is more vulnerable to scratches. With some sizes and types of sheets the lifting devices J need not be used.

It will be seen that an important novelty in this sheet separation, different from previous separating devices utilizing magnetic fields, is that the actual separation is caused by reluctance gaps c imposed on each sheet. According to the present arrangement if the magnetomotive force of the coils E associated with the magnets is increased, the flux density of the air gap will increase and the sheet separation will be reduced.

In adapting the reluctance gap separation principle to high speed production of sheet feeding as in the instant invention, provision is made for engaging the top sheet in the zone of separation and withdrawing it away from the third side on which the rear magnet is located. This is illustrated as suction cup feeding devices K which engage the forward or lower edge of the topmost sheet and draw it outwardly between the side magnets inserting it into constantly rotating feed rollers L (Fig. 3) which transfer it from the zone of separation. Since the same magnetic force is

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continuously applied to the magnets during operation of the apparatus, the removal of a sheet at the top of the zone of separation has the effect of causing all of the floating sheets within the zone to move up one space. This opens up a space for a new sheet which passes into the bottom of the zone from the stack.

A preferred embodiment of the invention as disclosed in the drawings comprises an apparatus, the principal parts of which are indicated in more or less detail in Figs. 1 to 5, inclusive. Vertical frames 21 constitute supports for the elevator and other feeding parts of the machine. These frame supports are tied together at the top by a front bar 22 and by a rear bar 23. At the bottom the frames 21 may be bolted to the floor by angle irons 24.

The skid B is loaded with plate in the usual manner. The loaded skid is then brought into position for insertion into the apparatus by a truck or other conventional sheet delivering device. Such a truck as well as the elevator device of the present invention are similar to that shown and described in the H. W. Lindgren United States Patent 2,375,241, granted May 8, 1945, on Sheet stacking machine.

The skid of sheets is pushed into the open back of the apparatus in between the two rear upright frames 21 and is deposited on a floating platform 25 (Figs. 2 and 3) of the elevator A. By using the term "floating" it is intended to convey that the platform can be shifted slightly in any direction. Rollers 26 which are carried in side channel irons 27 mounted on the platform 25, support the load and permit easy placing of the skid and the stack of sheets onto the platform. In moving the skid of sheets into the elevator, front bars 28 form a limiting stop for the front edge of the stack (Figs. 2 and 3). The bars 28 may be secured to the floor at the bottom and near the top are held on a cross bar 29 through the medium of connecting Z bars. The cross bar 29 is fastened to the forward upright frames 21.

At the top each front bar 28 is secured to and supports a non-magnetic cap bar 30. The cap bar extends in front of the magnetic zone of separation C and being non-magnetic has no attraction for the separated sheets. It is over the top of this cap bar that the sheets are removed singly by the feeding device K as will be explained later.

Vertical chains 31 are secured to the platform and form the supporting elements for the load placed thereon. These chains extend to and operate over sprockets 32 mounted on horizontal sprocket shafts 33. There are four such chains 31, two on each side and the four sprockets are located adjacent the corners of the apparatus.

Two sprockets 32 on each side of the apparatus are mounted upon a single sprocket shaft 33 and the two sprocket shafts are driven in suitable manner for lifting the stacks of sheets a gradually as the sheets are separated and are fed by the apparatus. Shafts 33 are journaled in bearings 34 carried in side bars secured to the upright frames 21. A connecting cross shaft 35 (Figs. 1 and 3) extends at right angles to and beneath the sprocket shafts 33 and provides a connecting drive between the two sprocket shafts. Such a connecting shaft is journaled inside bearings 36, 37 carried indirectly in the forward upright frames of the apparatus. The drive connection between the two shafts 33 and the shaft 35 is made by a worm gear 38 on each sprocket shaft and the two worm gears mesh with worms

39 carried on shaft 35. For the purpose of the present invention shaft 35 may be considered as the drive shaft for the elevator.

A non-magnetic frame surrounds and is secured to the four vertical frames 21 and provides indirectly for a support for the magnets D. Such a frame is formed by two side bars 41 (Figs. 1, 2 and 3), a front bar 42 and a rear bar 43. These bars are formed of non-magnetic material such as brass and provide an insulation between the frame of the machine and the magnets. The side bars 41 directly support the bearings 36, 37 at the front of the machine so that the drive shaft 35 is retained in its proper driving position on the upright frames. These bars 41, 42 and 43 are located just beneath the shaft 35 (see Figs. 2 and 3) and are further below the sprocket shafts 33.

A cross plate 45 (Fig. 1) extends across and is mounted on top of the side bars 41 this plate being substantially in the center of the sheet space of the elevator A. A transverse plate 46 is secured to the center of the plate 45 and extends back over the top of the rear bar 43. These plates 45, 46 are of magnetic material such as steel and provide a sliding support for the magnets D and also form a path for magnetic flux, as will be fully explained later. Being carried on the insulating frames 41 and 43 they, together with the immediate magnet parts, are magnetically insulated so that the elevator A and supporting parts are not magnetically charged.

The rear or intermediate magnet D is best illustrated in Figs. 2 and 4 and includes a pole piece or block 51 which is carried on the lower end of a core 52 which extends through the rear magnet coil E. Above the coil the core passes into and is supported by a sliding member 53 which is mounted upon the plate 46. The sliding member is formed with an upstanding lug 54 through which passes a horizontally disposed threaded shaft 55.

Such a shaft extends through and has rotation within a bracket 56 (see also Fig. 3) resting on the rear bar 43. Outside of the bracket 56, the shaft 55 is formed with a squared head 57 by means of which the shaft can be engaged and rotated as by a suitable wrench. Upon rotation of the threaded shaft the sliding member 53 is caused to move toward or away from the center of the machine. This locates the rear magnet at the proper position relative to the stack of sheets being separated in the device.

Each side magnet D (Figs. 3 and 5) includes a pole piece or block 61 which is carried on the lower end of a core 62 which extends through the corresponding magnet coil E. Each core above its magnet coil is connected to a sliding member 63 which is slidably mounted upon the cross plate 45. The two sliding members 63 are equally and adjustably spaced from the center of the apparatus so that the magnets carried thereby at all times are positioned in proper relation to the side edges of the sheets passing into the magnetic zone of separation C.

Each sliding member 63 is formed with an upstanding lug 64 through which passes an adjustment shaft 65. Such an adjustment shaft is provided with threaded sections 66 the threads of which are disposed in opposite directions and each threaded section rotates within and has threaded engagement in the lugs 64 of the corresponding sliding member 63.

The adjusting shaft 65 extends across the machine and is journaled for rotation in side brack-

ets 67 (Figs. 1 and 3) which are resting on each side of the side bars 41. The two ends of the shaft 65 extend out beyond the respective brackets 67 and each end is formed with a square head 68. By this means the adjustment shaft may be rotated in the desired direction from either side of the machine by application of a wrench onto either head section 68. Thus it will be seen that this construction of a common shaft for both side magnets insures that the side magnets will at all times be centered in any adjusted position relative to the center of the machine.

The magnet block or pole piece 51 of the intermediate magnet, as best shown in Fig. 4, is tapered on its inner face as by an inclined surface 71. This tapered construction provides the air gap c for the rear magnet, as already fully described.

The non-magnetic guide G of the rear magnet is formed from sheet material with a series of walls. This includes a slightly off vertical wall section 72 terminating at the top in a rounded edge 73. At the bottom this wall part merges into an angular or tapered wall part 74 which extends into a horizontal wall 75. This non-magnetic guide is secured to the pole piece 51 through the medium of a non-magnetic spacer plate 76.

Such a guide is formed of non-magnetic material such as stainless steel and its construction provides for the proper locating of the sheets a longitudinally while in the magnetic zone of separation C. The inclined surface 74 of the guide insures the proper and continuous centering of the stack b as it rests on its floating platform 25 and insures proper guiding of a sheet leaving the top of the stack as it is being lifted by the elevator A. The wall section 72 assists in aligning the edges of the sheets adjacent the intermediate magnet while in the magnetic areas F.

Owing to the inclined face 71 of the pole piece 51, a uniformly decreasing separation is had between the edges of the sheets and the face of the magnet extending from the top of the stack and upwardly into the magnetic field or zone C. This magnet construction which is present in all of the magnets effects the different magnetic strengths in the uniformly increasing magnetic areas F starting from the bottom and approaching the top maximum strength field.

The side magnets D (Fig. 5) are formed in a similar manner to the intermediate magnet and each side magnet has its own non-magnetic guide G. The magnet pole piece 61 is formed with an inclined inner face 81. Its non-magnetic guide consists of a slightly off vertical wall section 82 terminating at the top in a flared edge 83. At the bottom this wall part merges into an inclined wall 84 which extends into a lower horizontal wall section 85. This non-magnetic guide G is secured to the bottom of the magnet pole piece 61 through the medium of a non-magnetic spacer plate 86.

The magnet D to the right (Fig. 5) is of similar construction and consists of a pole piece or magnet block 91 having an inclined inner face 92. The non-magnetic guide G for this magnet includes a wall 93 which is slightly off the vertical, this wall terminating at the top in a flared edge 94. At the bottom this wall part merges into an inclined wall 95 which extends into a lower horizontal section 96. This non-magnetic guide is secured to the magnet pole piece 91, a non-magnetic spacer block 97 being provided for this purpose.

This right-hand magnet for many sheet feed-

ing conditions may be the same as that on the left. However, it is sometimes desirable to align one edge of the sheets while in the separation zone C and Fig. 5 shows one way of doing this. This magnet is also formed with a sheet edge aligning unit consisting of a finger 98 pivoted at 99 in the spacer block 97. This finger is urged inwardly against the right hand side edges of the separated sheets within the zone of separation C by a spring 100. Spring 100 is seated in a bore formed in the magnet pole piece 91 the inner end of the spring pressing against the finger 98.

The inclined walls 84, 95 of the guide members G for the two side magnet pole pieces 61, 91 insure the proper placing of the stack of sheets as the upper part of the rising stack moves in between the side magnets. The walls 82, 93 are not parallel but are spread apart a slight distance at the top. This construction removes any confinement on the side edges of a sheet *a* passing into the zone of separation C. The minimum spacing of the walls 82, 93 at their merger with the inclined walls 84, 95 insures unrestricted magnetic action upon the sheets while within the magnetic fields after each sheet has been properly centered.

As the rising and floating sheets in the zone C approach the top, each sheet is pushed over toward the left hand magnet D and even though there is variation in width of sheets, the separated sheets within the magnetic areas F are aligned along one side and against the wall 82 of the non-magnetic guide G on that side. The top floating sheet is then ready for its lateral removal by the feed rollers L over the cap bar 30, but before describing this attention will be had to the path of magnetic flux through the machine parts which give the magnetic zone of sheet separation C.

Different arrangements of the magnets D may be had in order to provide the proper magnetic flux in the magnetic areas F. Fig. 6 shows in diagram a schematic path of travel of the magnetic flux through the sheet *a* when the side magnets D are of the same polarity and when a single rear or intermediate magnet is used of a different polarity. For example, the side magnets D may both be south poles while the third magnet D is north.

This Fig. 6 also indicates the magnetic flux as being induced electrically for the magnetic areas F as by passing an electric current through all three magnet coils E. Electrical energy may be caused to flow along a plus wire *d* into the left side magnet coil E energizing the left side magnet. The current then passes by way of a wire *e* to the right side magnet coil E energizing the right side magnet. From this magnet coil the current passes by way of a wire *f* to the rear magnet coil E thus energizing the rear magnet. A wire *g* leading from the rear magnet coil E may be a minus wire the two wires *d* and *g* being connected to a suitable source of electrical current, as shown in the drawing.

The path of the magnetic flux is indicated by dotted lines in Fig. 6 and follows two curved paths *j* in the zone of magnetic separation C passing from the two side magnets through the sheet *a* and into the rear magnet D. From the rear magnet this flux passes through the core 52 into the steel plate 46. For purposes of illustration there is shown two arms of the plate 46 but it will be understood that in reality there is only a single straight plate 46.

The magnetic flux passes from the end of the

plate 46 into the plate 45. It is at this point that there is a dividing of the path of travel, the flux passing both to the right and to the left toward both ends of the plate 45 and thence into the cores 62 of the two side magnets. This completes the magnetic circuit as it is effective in the various magnetic parts of the machine.

The back lifting devices J engage the topmost sheet adjacent its rear edge in two spaced regions. This insures a greater separation of the rear edge of the topmost sheet *a* from the sheet below and this minimizes scratching of the sheets as a sheet is being fed from the magnetic separation zone. Such lifting devices tend to unhook any bent edge sheets which otherwise may lock together. Since movement of the devices is relatively rapid the resulting vibration of the spread apart sheets in the zone insures more positive separation between sheets even though a tacky or sticky condition of the sheets prevails. The lifting devices J include suction cups 111 (Figs. 1, 3 and 4). Each suction cup is carried on the lower end of a vertical pipe 112.

The pipe 112 may be a part of a conventional suction cup mechanism and is preferably mounted for slight vertical movement within a bracket 113. The proper suction connection is made to the suction cup through the pipe 112 and the desired vertical movement of the suction cup is had in conventional manner.

By means of the slight lifting of the topmost sheet adjacent the rear edge and intermediate its width any tendency that the sheet may have of sagging in the middle is overcome. This presents a better feeding position for the sheet and insures that the sheet will completely clear any mechanism connected with the magnets D or parts of the elevator A.

When the sheet is being brought into its raised position by the lifting devices J, the front edge of the sheet is engaged by a pair of suction cups 115 which form a part of the suction cup feeding devices K. Two suction cups engage the sheet along its forward edge and lift it to a position above the cap bar 30. The suction cups 115 then move forward carrying the sheet above the cap bar and inserting its forward edge in the rotating feed rollers L.

Each suction cup 115 is carried on the lower end of a pipe 116. The two suction cups 115 and the associated pipes 116 may be of usual conventional style and are supported and controlled in a manner first to engage the forward edge of the topmost sheet in the zone of separation C. Then the sheet is lifted vertically to the position shown in Fig. 3 of the drawings. Following this the suction cups 115 move forward sufficiently to insert the front edge of the sheet into the feed rollers L. During this forward feeding movement the rear part of the sheet will easily slip along the holding faces of the suction cups 111 without breaking the vacuum or if desired the vacuum can be cut off from the cups.

Feed rollers L are two in number and are disposed on shafts 121 (Figs. 1 and 3) arranged in vertical alignment one with the other. The shafts 121 are journaled in bearings. These bearings may be a part of a separate machine into which the sheets are fed for further treatment. For example, the sheets may be introduced into a coating machine in which case the feed rollers L will constitute a part of the coating machine. The rollers and the shafts are rotated in any suitable manner as through proper gearing with the drive mechanism of the coating machine.

It is thought that the invention and many of its attendant advantages will be understood from the foregoing description, and it will be apparent that various changes may be made in the form, construction, and arrangement of the parts of the apparatus mentioned herein and in the steps and their order of accomplishment of the process described herein, without departing from the spirit and scope of the invention or sacrificing all of its material advantages, the apparatus and process hereinbefore described being merely a preferred embodiment thereof.

I claim:

1. The method of individually feeding stacked sheets of metal by traversing a magnetic field of separation, which consists in maintaining a magnetic field by the introduction of varying degrees of flux from spaced magnet poles to produce strata of magnetic flux in said field having a minimum flux density at one boundary of the field and increasing to a maximum flux density at the opposite boundary, introducing the sheets into said magnetic field at the region of minimum flux density to magnetize the sheets so that they move toward the region having the greatest flux density, and spacing the magnetized sheet edges from said magnetic poles to create a reluctance gap for each sheet to cause separation of the sheets from one another while within the field.

2. The method of individually feeding stacked sheets of metal by traversing a magnetic field of separation, which consists in introducing flux into said field from spaced poles, maintaining said flux in successive magnetic areas approaching horizontal positions in said field, each of said areas containing a reluctance gap between the poles and sheet edges, the reluctance gap of one area varying from that of an adjacent area, whereby said flux permeates said areas in layers of varying magnetic forces with the maximum force at the top, and introducing horizontally disposed sheets into the lowermost of said magnetic areas to magnetize the sheets so that they separate and move upwardly to the top of said field.

3. The method of individually feeding stacked sheets of metal by traversing a magnetic field of separation, which consists in introducing magnetic flux into said field from spaced poles, maintaining in said field magnetic areas having different magnetic forces maintaining in each of said areas a reluctance gap between the poles and the sheet edges, said reluctance gap varying between a maximum at one and a minimum at the opposite boundary of said field, introducing the sheets into said magnetic field at the boundary of minimum flux density to magnetize the sheets so that they separate and move toward the boundary of the field having the greatest density, and successively removing individual sheets from the maximum magnetic area as they are drawn into the same.

4. The method of individually feeding stacked sheets of metal by traversing a magnetic field of separation, which consists in elevating a stack of sheets with the sheets in horizontal position, introducing magnetic flux into said field from spaced poles arranged at the edges of the sheets and producing superposed areas of flux adjacent the top of the stack to magnetize the sheets and to effect their upward movement into the magnetic areas of increasing magnetic forces, each of said areas containing a reluctance gap between the poles and sheet edges, the reluctance gap of one area varying from that of an adjacent area

resulting in separation of adjacent sheets during their passage through the field.

5. The method of individually feeding stacked sheets of metal by a field of magnetic areas of separation, which consists in elevating a stack of sheets with the sheets in horizontal position, creating magnetic areas in ascending layers of increasing magnetic forces beginning substantially at a position just above the top of the stack by the introduction of magnetic flux from magnet poles spaced from the edges of the sheets to magnetize the sheets and to cause them to rise into the denser flux layers of the magnetic field, upwardly decreasing reluctance gaps in said field separating adjacent sheets during their passage through the field, and successively removing the top sheet at the time another sheet is presented to the bottom of the magnetic field by the elevation of the stack of sheets.

6. The method of individually feeding stacked sheets of metal by traversing a field of magnetic areas of separation, which consists in producing and maintaining said field as a number of superposed magnetic areas of increasing magnetic forces from bottom to top of the field by the introduction of magnetic flux from spaced magnet poles through upwardly decreasing reluctance gaps, introducing the sheets into the bottom of said magnetic field to magnetize the sheets so that they separate, float and move up through the increasing magnetic flux of the areas, aligning the sheet edges while the sheets are thus magnetized, and successively removing individual sheets from the top of said magnetic field.

7. The method of individually feeding stacked sheets of metal by traversing a field of magnetic areas of separation, which consists in elevating a stack of sheets with the sheets in horizontal position, maintaining said magnetic areas as angularly disposed layers of upwardly increasing magnetic forces adjacent the top of the stack by the introduction of magnetic flux from magnet poles through upwardly decreasing reluctance gaps arranged at opposite side edges and at an intermediate edge of the sheets to magnetize the sheets and cause them to separate and traverse the said magnetic layers, each sheet passing from a lesser to a greater magnetic area of force while floating from a horizontal position into the upper portion of the field where it is at an angle to the unseparated portion of the stack, and removing the topmost sheet in the field by shifting it laterally away from said intermediate magnet pole and between said opposed side magnet poles.

8. In an apparatus for individually feeding stacked sheets of metal by traversing a magnetic field of separation, the combination of spaced magnet poles having opposed inclined faces for maintaining the field in layers of varying magnetic forces having a minimum flux density and a maximum flux density, means for introducing the sheets into said magnetic field and in a layer of minimum flux density to magnetize the sheets so that they move toward the layer having the greatest flux density, and non-magnetic guides arranged adjacent said magnet poles for spacing the magnetized sheet edges from the poles to create a reluctance gap for each sheet whereby the sheets are separated from one another while within the field.

9. In an apparatus for individually feeding stacked sheets of metal by traversing a magnetic field of separation, the combination of cooperating spaced magnets for maintaining the magnetic field therebetween, said cooperating magnets be-

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ing spaced further apart at the bottom of said magnetic field than at the top to create varying magnetic forces within the field with the maximum force at the top, means for introducing horizontally disposed sheets into the bottom of said magnetic field to magnetize the sheets so that they move upwardly toward the top of the field, a non-magnetic guide arranged adjacent each magnet for spacing the magnetized sheet edges from said magnets to create a reluctance gap for each sheet less than the flux density of the sheet to cause separation of the sheets one from another while within said magnetic field, and feeding devices for successively removing individual sheets from the top of said magnetic field.

10. In an apparatus for individually feeding stacked sheets of metal by traversing a magnetic field of separation, the combination of cooperating spaced magnets for maintaining the magnetic field the inside faces of said magnets being tapered to provide a greater space between opposed magnets at the bottom than at the top so that magnetic flux from the magnets creates layers of varying magnetic forces within the field with the maximum forces at the top, said opposed magnets also having inclined upper surfaces so that said magnetic layers between magnets form a fan-shaped magnetic field, means for introducing horizontally disposed sheets into the bottom of said field to magnetize the sheets so that they move upwardly from a layer of lesser to a layer of greater magnetic force and from a horizontal position into an inclined position, non-magnetic guides arranged adjacent the tapered faces of said magnetic poles to prevent the sheet edges from engaging said magnets thereby creating reluctance gaps at the sheet edges to separate the sheets from one another while within the field, and feeding devices for successively removing individual sheets from said top inclined position.

11. In an apparatus for individually feeding stacked sheets of metal by traversing a magnetic field of separation, the combination of cooperating spaced magnets for maintaining the magnetic field by the introduction of magnetic flux effective in the field as varying areas of magnetic forces, means for introducing the sheets into said magnetic field at an area of minimum flux density to magnetize the sheets so that they have the tendency to move toward an area of greater density, fixed non-magnetic guides located adjacent the magnets for spacing the magnetized sheet edges from said magnets to create a reluctance gap having a flux density less than the flux density in said magnetized sheets to separate the sheets from one another while within the magnetic field, said guides having inner faces for correctly centering each sheet as it enters the magnetic field and being tapered to release the centered sheet, and feeding devices for successively removing individual sheets from the maximum magnetic area as they are drawn into the same.

12. In an apparatus for individually feeding stacked sheets of metal by traversing a magnetic field of separation, the combination of a sheet elevator for lifting a stack of sheets with the sheets in horizontal position, cooperating magnets arranged at opposite sides and along an intermediate side of said stack, the bottom of said magnets being spaced further apart than the top for maintaining adjacent layers of varying magnetic force in said magnetic field adjacent the top of the stack, said elevator introducing a sheet from the top of the stack into the bottom of said

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magnetic field to magnetize the sheets to a degree of saturation sufficient to overcome the downward force of gravity and thereby to raise each sheet, fixed non-magnetic guides mounted on said magnets for spacing the magnetized sheet edges from said poles to create reluctance gaps for separation of sheets one from another while within said field and for centralizing the stack of sheets prior to entering said magnetic field, and feeding devices for successively removing individual sheets from the top of said magnetic field.

13. In an apparatus for individually feeding stacked sheets of metal by traversing a magnetic field of separation, the combination of spaced magnets having opposed inclined faces for maintaining magnetic areas of varying magnetic forces in said field, means for introducing the sheets into said magnetic field so that the sheets are magnetized and move toward areas of the field having increasing magnetic force, non-magnetic guides secured to said magnets and interposed between the sheet edges and the adjacent faces of the magnets for spacing the sheet edges from the magnets to create a reluctance gap for each sheet and to separate the sheets from one another while within said field, spring means on one of said guides for locating one edge of each sheet against the other of said guides as a sheet enters the said field to control its position, and feeding devices for removing said located sheet from said magnetic field.

14. In an apparatus for individually feeding stacked sheets of metal by traversing a magnetic field of separation, the combination of a platform for holding a stack of sheets, spaced magnets of like polarity located on opposite sides of the sheets on said platform, a cooperating intermediate magnet of opposite polarity located adjacent the rear of said sheets, means for energizing said spaced and said cooperating magnets so that the lines of force passing through the magnets and into the space between the magnets create layers of magnetic flux, means for maintaining the said layers at different strengths of magnetic force, means for introducing sheets from the stack on said platform into the magnetic field layer of minimum magnetic force to magnetize the sheets and cause their movement through the magnetic field, feeding devices for removing the sheets singly from the layer of maximum magnetic force, and non-magnetic guides for spacing the magnetized sheet edges from said magnets during the sheet movement through the magnetic field to create reluctance gaps for separation of adjacent sheets while within said field.

15. In an apparatus for individually feeding stacked sheets of metal by traversing a magnetic field of separation, the combination of spaced magnets of like polarity having opposed inclined faces located opposite one another and a cooperating intermediate magnet of opposite polarity having an inclined face and located to one side of and intermediate said spaced magnets, a metallic magnetic support for holding said magnets and for providing a magnetic path by means of which said intermediate magnet is made weaker than said side magnets, means for energizing said magnets so that the lines of force passing between magnets of opposite polarity are effective as layers of magnetic flux of different magnetic strength to cause movement of the sheets through the magnetic field, non-magnetic guides for spacing the magnetized sheet edges from the magnets to create a reluctance gap for separation of adjacent sheets while within said

field, feeding devices for singly removing a separated sheet by withdrawing from said weaker intermediate magnet, and means for introducing sheets into said magnetic field as sheets are removed therefrom to insure maintenance of substantially the same number of sheets in the magnetic field.

16. In an apparatus for individually feeding stacked sheets of metal by traversing a magnetic field of separation, the combination of an elevator for maintaining the sheets in horizontal position while lifting the same, a support located above said elevator, magnets carried by said support and located in spaced relation on three sides of the sheets on said elevator, means for energizing said magnets to create layers of magnetic areas of separation above the stack of sheets the magnetic flux in said areas being at a minimum at the top of the stack and increasing from above that position in ascending order within the field to magnetize the sheets as they are lifted into the field by said elevator and to cause the same to rise through said magnetic layers, non-magnetic guides for spacing the magnetized sheet edges from said magnets to create reluctance gaps for the sheets thereby separating the sheets from one another while in said magnetic field, and means for adjusting said magnets on said supports to adapt the apparatus to the size of sheets on said elevator.

17. In an apparatus for individually feeding sheets of metal from a stack by traversing a magnetic field of separation, the combination of spaced magnets the bottom edges of the magnets being in a horizontal plane and their top edges being in an inclined plane for maintaining a fan shaped magnetic field of separation, said magnets being angularly disposed relative to said stack for uniformly increasing the magnetic forces in said field extending in layers from bottom to top, elevator means for introducing horizontal sheets into the bottom horizontal magnetic layer to magnetize the sheets so that they float and move up through the increasing magnetic flux of the layers and into the top inclined layer, non-magnetic guides for spacing the magnetized sheet edges from said magnets to create reluctance gaps for each sheet in the field to separate the sheets one from another, and suction cups located above the floating sheet in said top field for engaging and for removing the top separated sheet.

18. In an apparatus for individually feeding stacked sheets of metal by traversing a magnetic field of separation, the combination of spaced magnets for maintaining a magnetic field of separation by the introduction of magnetic flux to produce varying magnetic forces in the layers of said field with the maximum force at the top, a sheet elevator for lifting the sheets into said magnetic field at the bottom layer of minimum flux density to magnetize the sheets so that they move toward and into the top layer of greatest flux density, non-magnetic guides for spacing the magnetized sheet edges from said magnetic poles to create reluctance gaps having flux density less than the flux density in said magnetized sheets to cause separation of the sheets while within the field, said guides having inclined opposite surfaces for centering the stack of sheets carried by said elevator entering said magnetic field, and suction cups for engaging and successively removing individual sheets from the top maximum magnetic layer.

19. In an apparatus for individually feeding stacked sheets of metal by traversing a magnetic

field of separation, the combination of spaced magnets arranged on three sides of a rectangular area constituting the magnetic field of separation, the bottom edges of said magnets being in a common horizontal plane with the top edges of opposite side magnets in an inclined plane with the higher part adjacent the magnet on the third side, the inner faces of said magnets being inclined from the vertical with the bottom edges enclosing a larger rectangular area than that at the top for creating a series of fan shaped superposed magnetic layers of varying magnetic forces, means for introducing sheets into the bottom magnetic layer of minimum flux density to magnetize the sheets so that they rise into upper layers of greater flux density, non-magnetic guides arranged adjacent said magnets for spacing the magnetized sheet edges from the magnets to create reluctance gaps for each sheet whereby the sheets are separated from one another while within the field, means for further lifting the higher end of a sheet when it reaches the top inclined magnetic layer, and feeding devices for removing said raised top sheet from said magnetic field.

20. In an apparatus for individually feeding stacked sheets of metal by traversing a magnetic field of separation, the combination of spaced wedge shaped side magnets and a center rear magnet arranged with their bottom edges in a horizontal plane for maintaining a lowermost magnetic layer of separation in a horizontal plane and with the layers above uniformly fanning out to an inclined layer on top, means for progressively increasing the magnetic forces in said layers to a maximum strength in the uppermost layer, a sheet elevator located below said magnetic field for lifting a stack of sheets to feed from the top of the stack horizontal sheets into the bottom of said magnetic field whereupon the sheets are magnetized and float up through the layers of increasing magnetic flux of the field, said rear magnet holding up the center of the rear sheet edges to minimize bending of the floating sheets, non-magnetic guides fastened to said magnets for spacing the sheet edges from said magnets to create reluctance gaps for each sheet in the field to separate the magnetized sheets one from the other, a front guide for the stack of sheets being lifted by said sheet elevator, a non-magnetic tip on said guide, and feeding devices located above the said field for engaging the lower end of the top sheet and for removing it from said magnetic field.

21. The method of individually feeding stacked sheets of metal by traversing a magnetic field of separation, which comprises maintenance of a magnetic field adjacent a magnetic pole and a stack of metal sheets producing strata of flux in said field varying between a minimum flux density at one and a maximum flux density at the opposite boundary of said field, introducing said stacked sheets into the stratum of minimum flux density, and guiding said sheets through said strata and spaced from said poles to the opposite boundary of said field, said sheets being separated in and moved through said strata by said magnetic flux.

22. In an apparatus for individually feeding stacked sheets of metal by traversing a magnetic field of separation, the combination of a plurality of spaced magnets located adjacent three edges of substantially rectangular magnetizable sheets arranged in a stack to create a magnetic field of separation in the outer portion

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of said stack, each of the magnets adjacent two opposed edges of said sheets having an inclined outermost face disposed with one end of said face spaced farther than the other end from the plane of the outermost unseparated sheet in said stack, with the farthest spaced end located adjacent an intermediately located magnet adjacent a third edge of the sheets for separating said sheets one from another and for fanning them out to facilitate removal of individual sheets from the outer portion of said stack.

23. In an apparatus for individually feeding stacked sheets of metal by traversing a magnetic field of separation, the combination of a plurality of spaced sheet separator magnets located adjacent at least three spaced peripheral points of magnetizable sheets arranged in a stack to create a magnetic field of separation in the outer portion of said stack, the stack facing side of at least one of said magnets being at an angle to the respectively adjacent side of said stack to create varying magnetic forces within said magnetic field of separation for separating said sheets one from another to facilitate removal of individual sheets from the outer portion of said stack.

24. An apparatus for individually feeding stacked sheets of metal by traversing a magnetic field of separation, comprising a sheet separator magnet located adjacent a stack of magnetizable sheets to create a magnetic field of separation in the outer portion of said stack, the stack facing side of said magnet being at an angle to the respectively adjacent side of said stack to create varying forces within said magnetic field of separation which increase in strength towards the

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outermost portion of said stack for separating said sheets one from another to facilitate positive removal of individual sheets from the outer portion of said stack.

25. The method of individually feeding magnetizable sheets from a supply of such sheets arranged in a stack by traversing a magnetic field of separation providing a stack having its outermost sheets separated and fanned out in substantially triangular fashion at acute angles to its innermost and unseparated sheets, which method comprises creating an effective zone of said magnetic field of separation at the outer portion of said stack, said zone having an outermost effective boundary substantially coinciding with the plane of the outermost separated sheet and an opposed innermost effective boundary substantially coinciding with the plane of said innermost and unseparated sheets, introducing said unseparated sheets into said zone of separation through said innermost boundary of said zone, and successively removing individual, separated sheets from said outermost boundary of said zone.

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