May 10, 1960 L. C. WILLIAMS 2,936,171

SHEET FEEDING APPARATUS

Filed Aug. 29, 1957 8 Sheets-Sheet 1

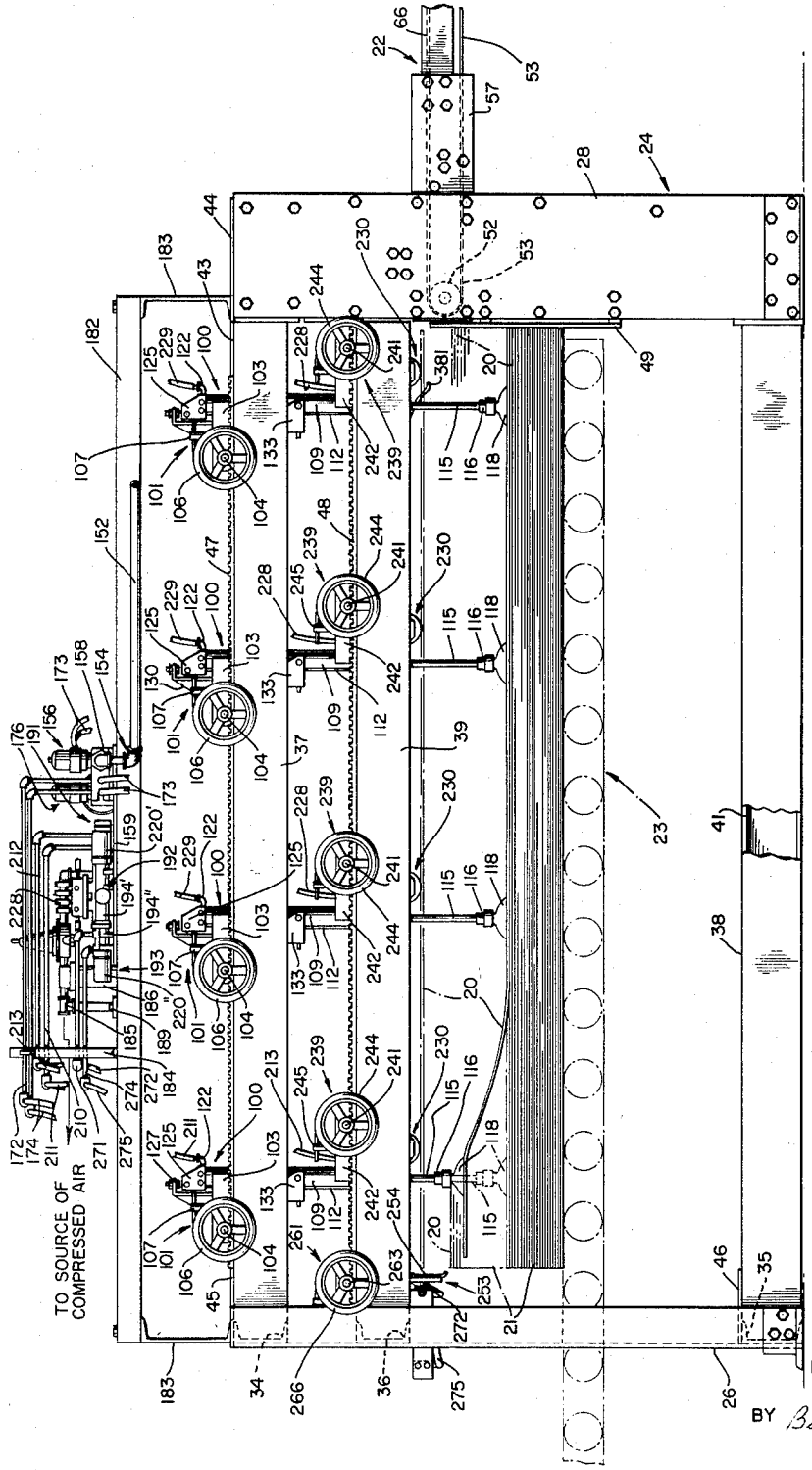


FIG. 1

INVENTOR
LEO C. WILLIAMS

BY Bauer and Seymour
ATTORNEYS

May 10, 1960 L. C. WILLIAMS 2,936,171

SHEET FEEDING APPARATUS

Filed Aug. 29, 1957 8 Sheets-Sheet 2

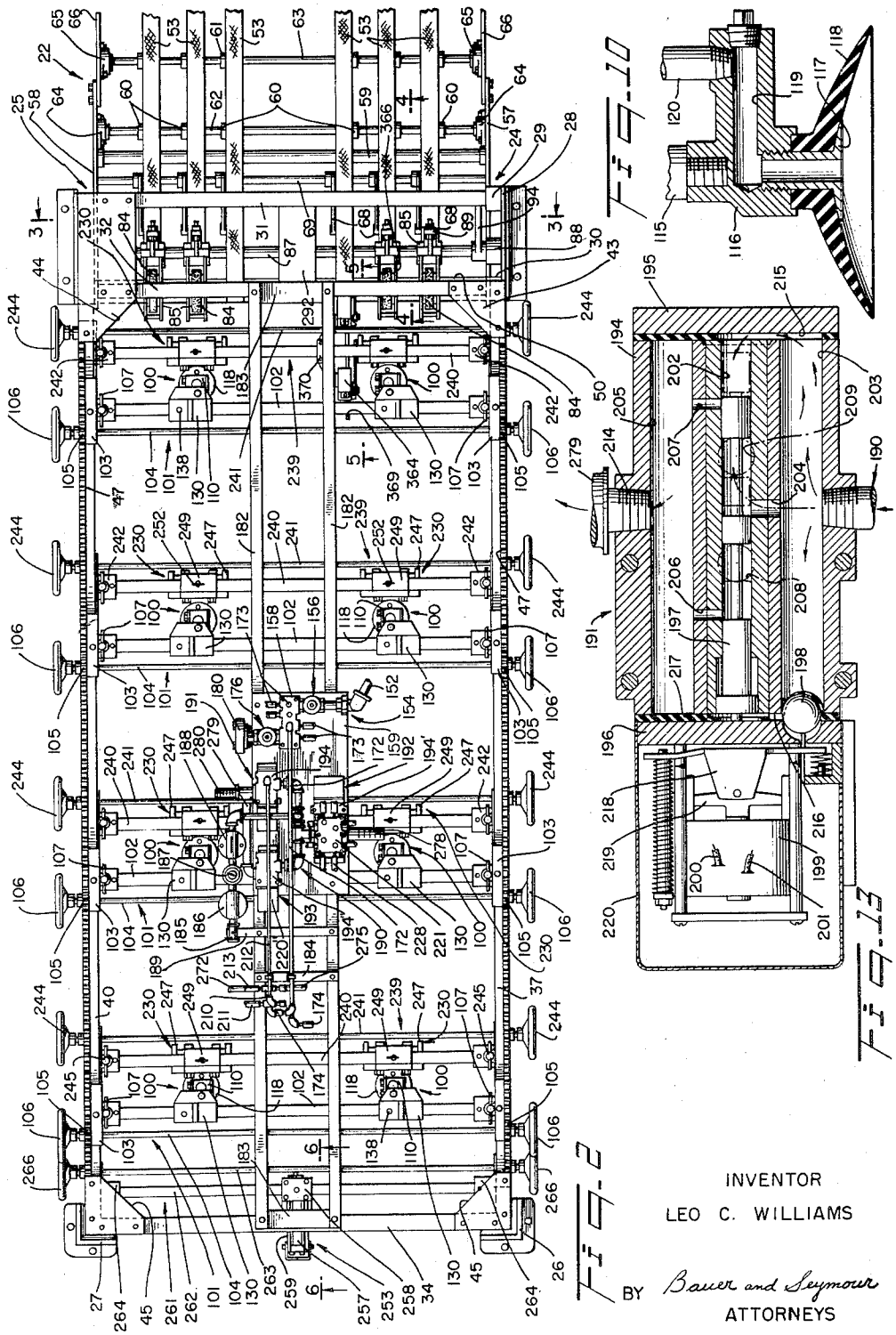


Fig. 2

Fig. 10

Fig. 12

INVENTOR
LEO C. WILLIAMS

BY Bauer and Seymour
ATTORNEYS

May 10, 1960 L. C. WILLIAMS 2,936,171

SHEET FEEDING APPARATUS

Filed Aug. 29, 1957 8 Sheets-Sheet 3

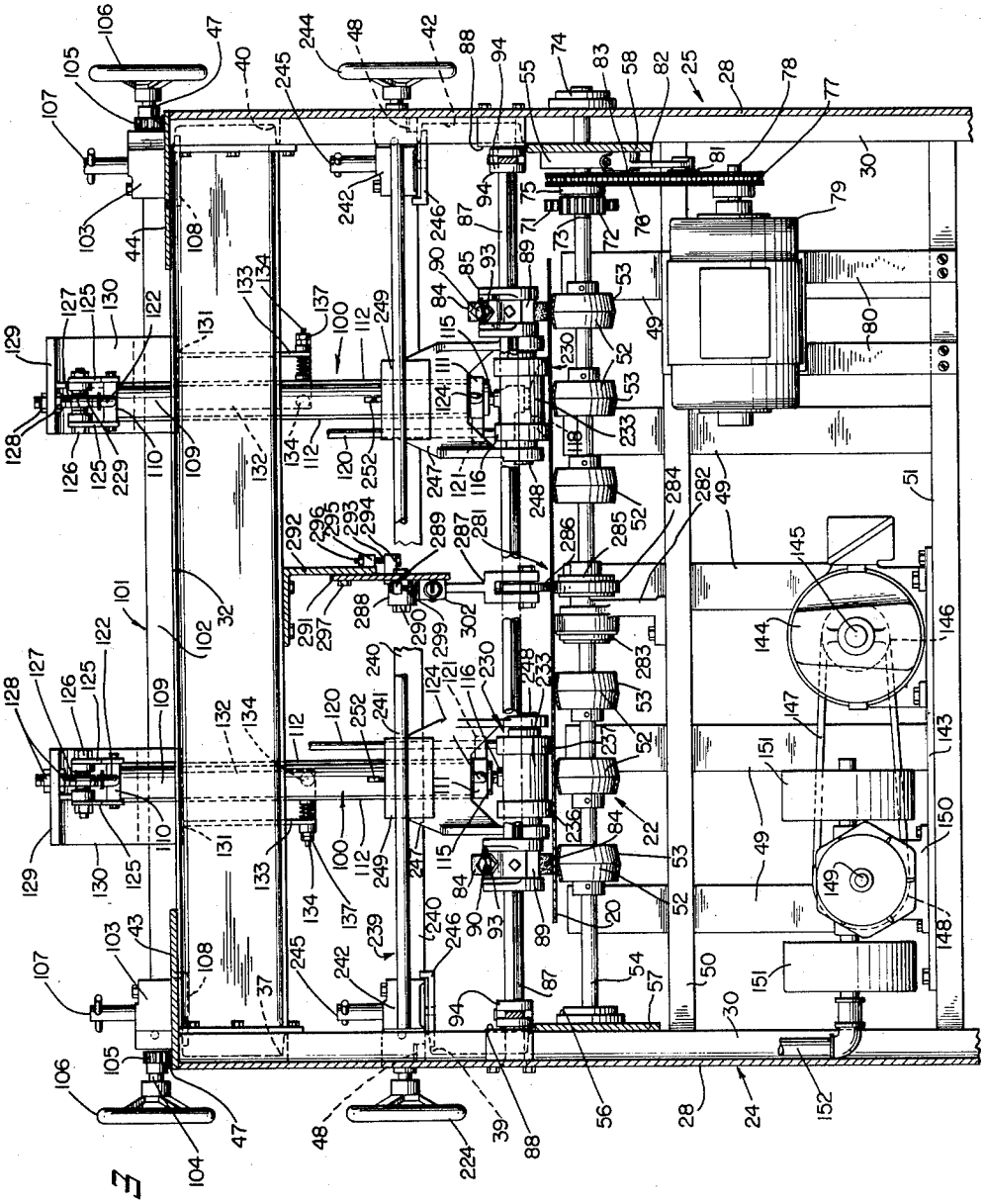


Fig. 3

INVENTOR
LEO C. WILLIAMS

BY Bauer and Seymour
ATTORNEYS

May 10, 1960 L. C. WILLIAMS 2,936,171

SHEET FEEDING APPARATUS

Filed Aug. 29, 1957 8 Sheets-Sheet 4

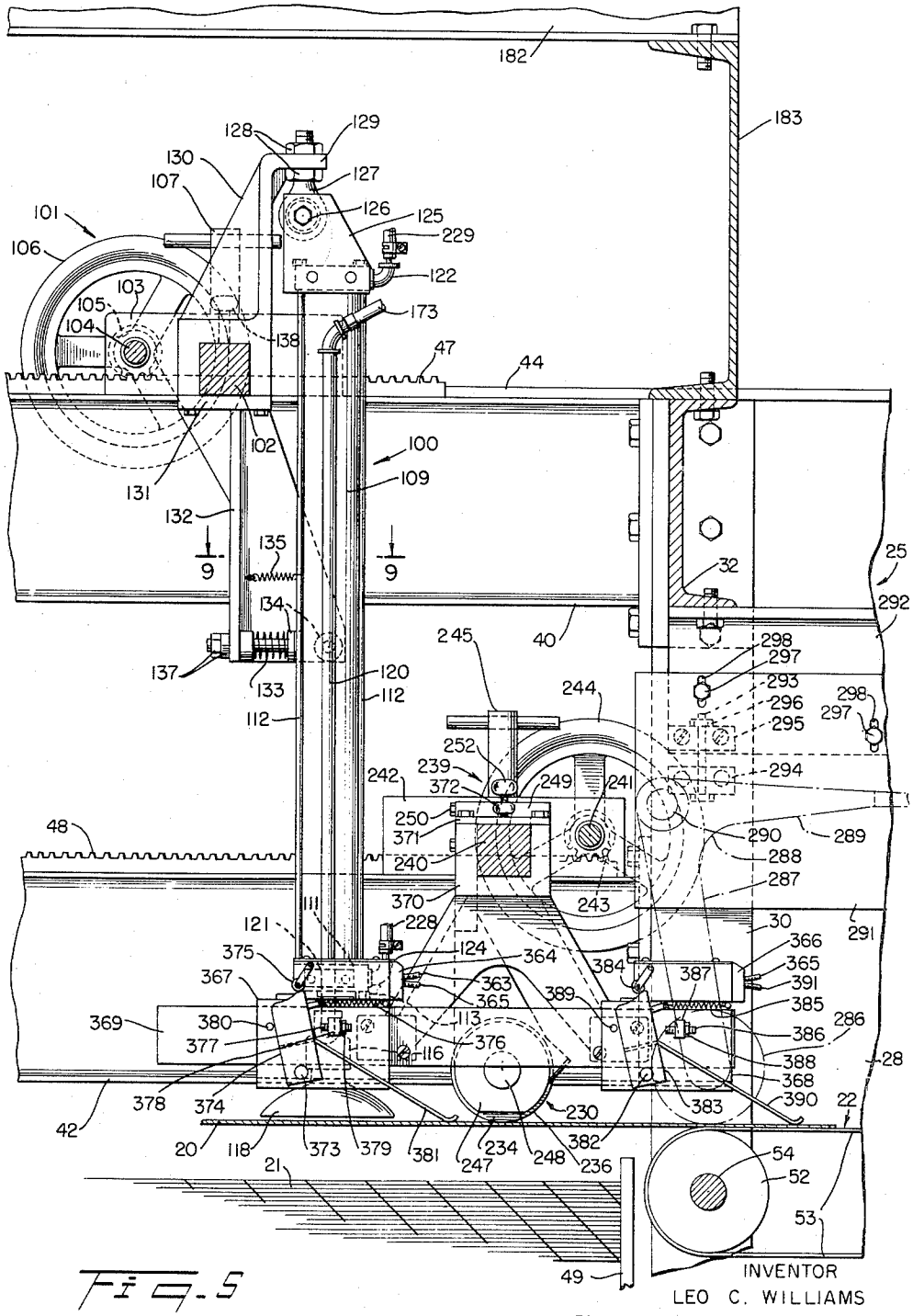


FIG. 5

INVENTOR
LEO C. WILLIAMS

BY

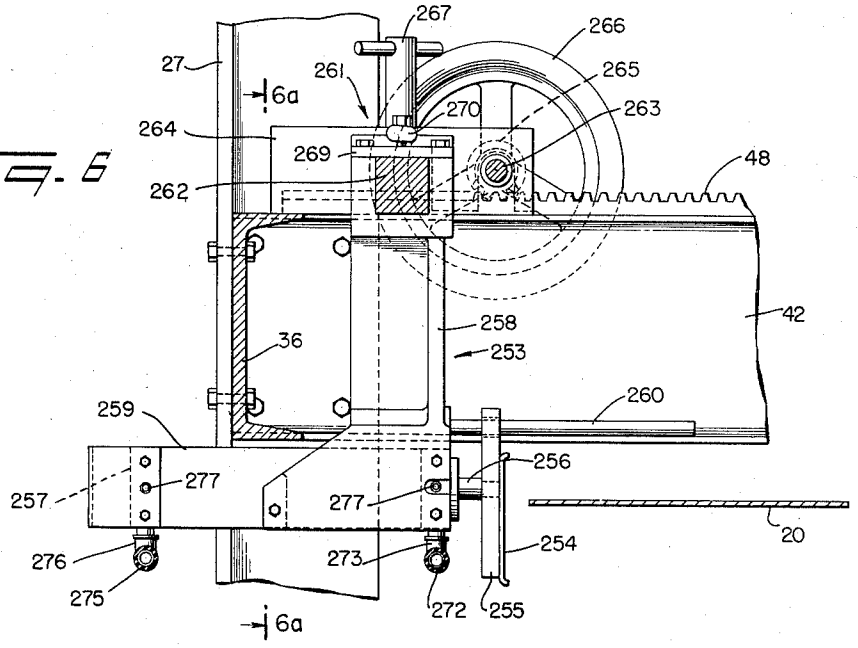
Bauer and Seymour
ATTORNEYS

May 10, 1960 L. C. WILLIAMS 2,936,171

SHEET FEEDING APPARATUS

Filed Aug. 29, 1957 8 Sheets-Sheet 5

Fig. 6



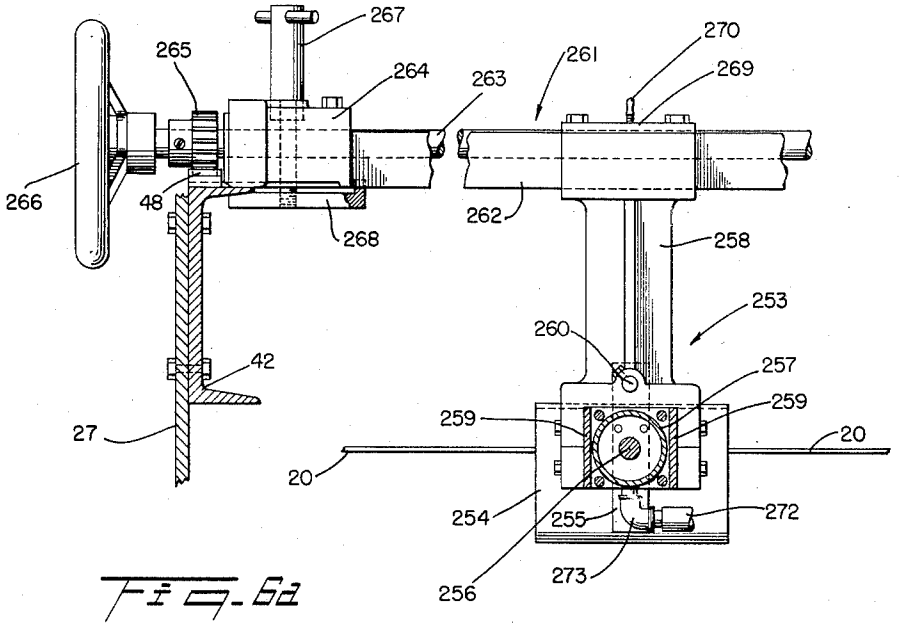


Fig. 6a

INVENTOR
LEO C. WILLIAMS

BY Bauer and Seymour
ATTORNEYS

May 10, 1960 L. C. WILLIAMS 2,936,171

SHEET FEEDING APPARATUS

Filed Aug. 29, 1957 8 Sheets-Sheet 6

Fig. 7

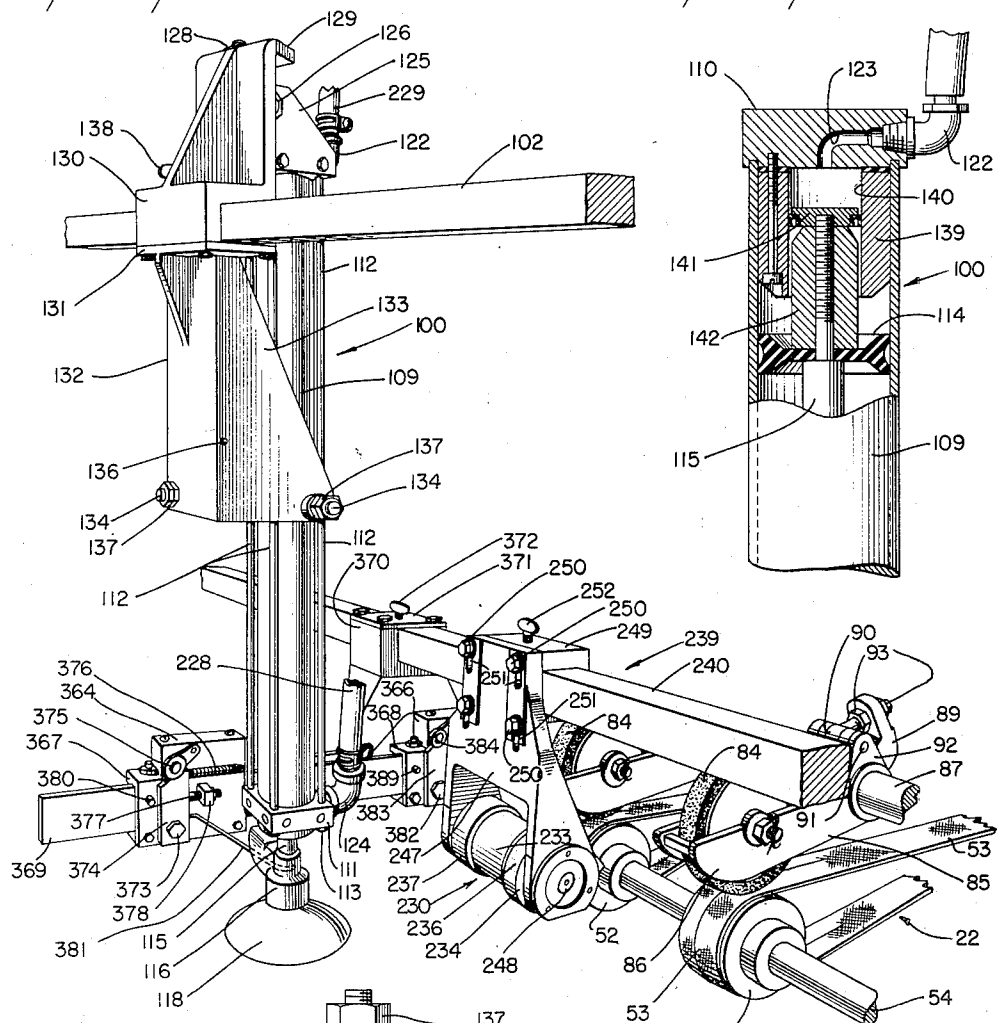


Fig. 8

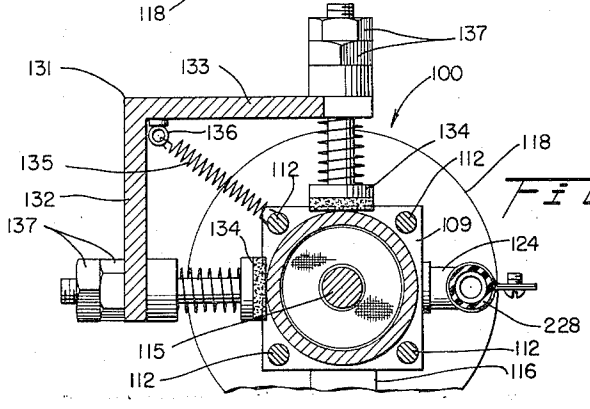


Fig. 9

INVENTOR
LEO C. WILLIAMS

BY Bauer and Seymour
ATTORNEYS

May 10, 1960 L. C. WILLIAMS 2,936,171

SHEET FEEDING APPARATUS

Filed Aug. 29, 1957 8 Sheets-Sheet 7

Fig. 4

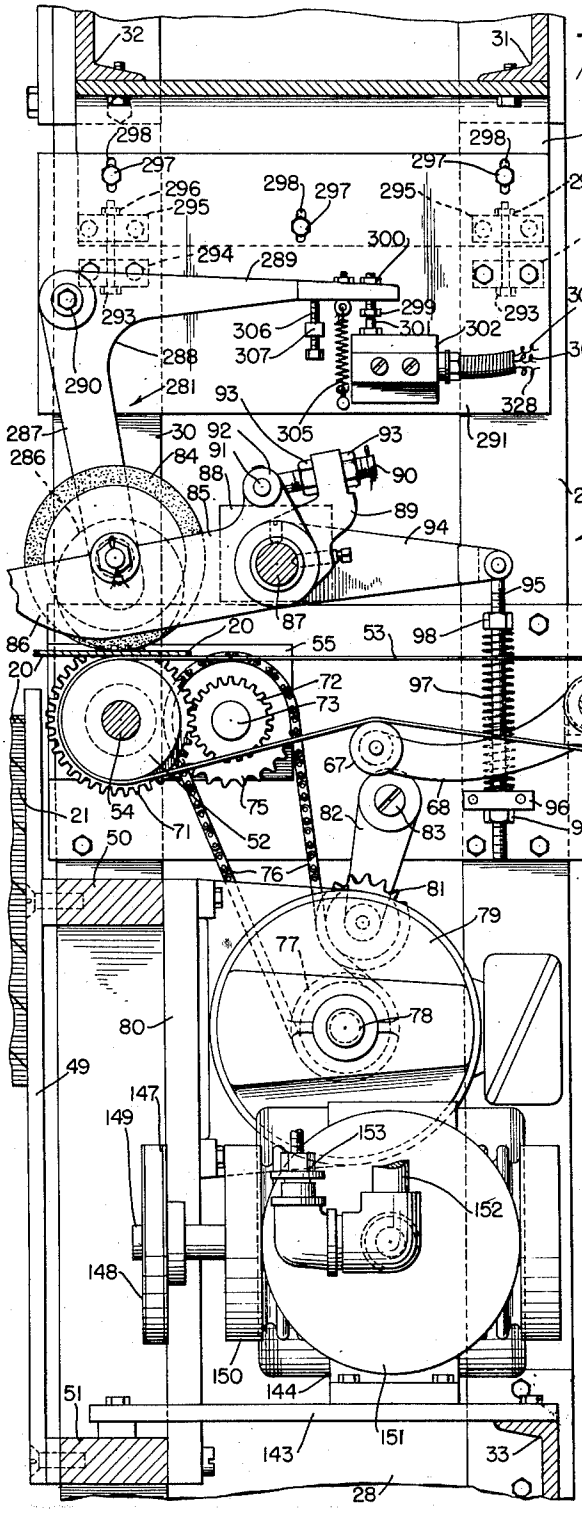


Fig. 11

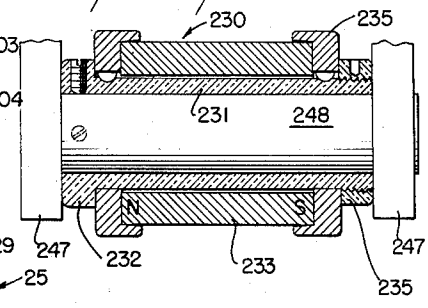
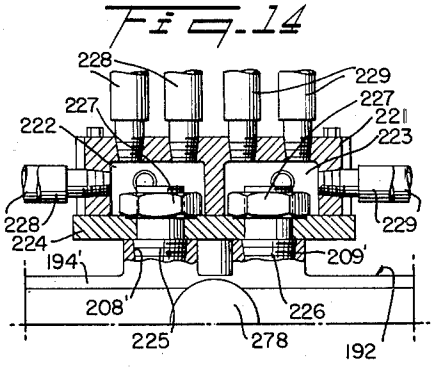


Fig. 14



INVENTOR
LEO C. WILLIAMS

BY Bauer and Seymour
ATTORNEYS

May 10, 1960 L. C. WILLIAMS 2,936,171

SHEET FEEDING APPARATUS

Filed Aug. 29, 1957 8 Sheets-Sheet 8

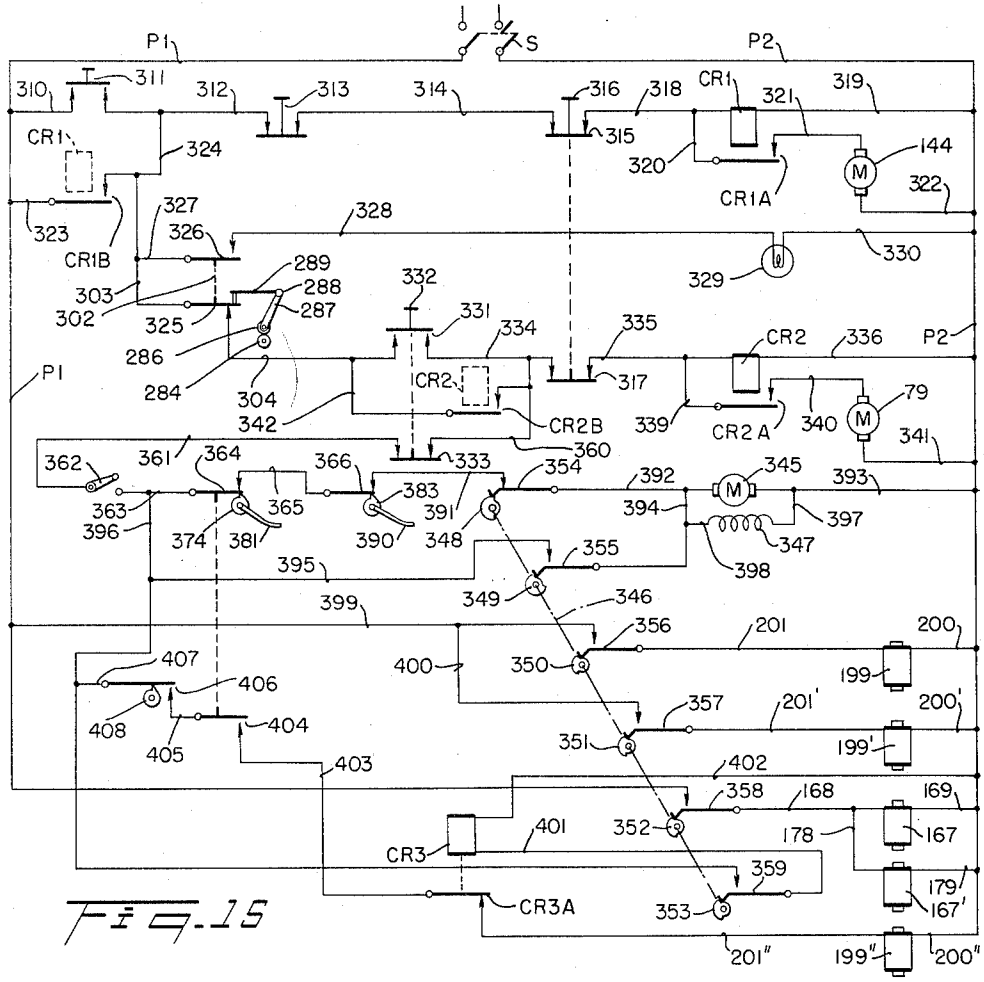


Fig. 15

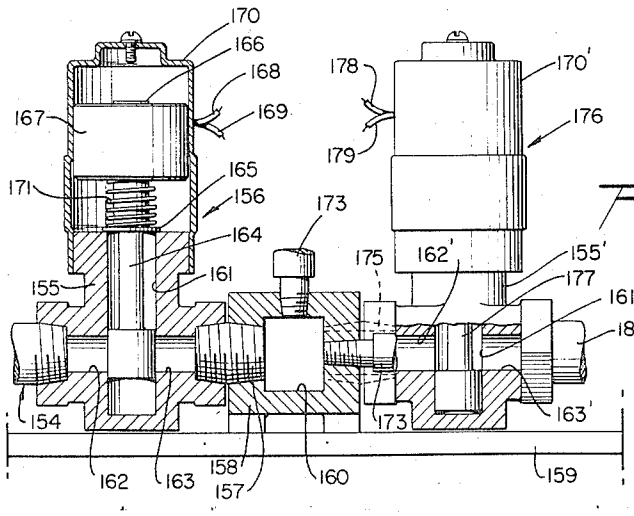


Fig. 12

INVENTOR.
LEO C. WILLIAMS

BY

Bauer and Seymour
ATTORNEYS

United States Patent Office

2,936,171

Patented May 10, 1960

2,936,171

SHEET FEEDING APPARATUS

Leo C. Williams, Pearl River, N.Y., assignor to Miehle-Goss-Dexter, Incorporated, Chicago, Ill., a corporation of Delaware

Application August 29, 1957, Serial No. 681,036

29 Claims. (Cl. 271—12)

This invention relates generally to sheet feeding apparatus, and particularly to a sheet feeder which is capable of feeding metal sheets of magnetic material and other sheets of a magnetic character in a larger variety of sizes, lengths and weights successively from the top of a pile thereof to machines and instrumentalities employed in the processing or making of appliances, drums, cans and other articles.

One object of the present invention is to provide an improved method of lifting and feeding relatively large and heavy metal sheets of magnetic material from the top of a pile thereof.

Another object of the invention is to provide an improved sheet feeder of novel, simple and durable construction that will rapidly and effectively feed relatively large and heavy metal sheets of magnetic material successively to various types of equipment for acting on such sheets.

Another object is to provide a sheet feeder of the character stated having a relatively small number of parts constructed, coordinated and operated to insure efficiency, low manufacturing, installation and maintenance costs, and "fool-proof" operation.

Still another object is to provide an improved sheet feeder wherein substantially all of the parts are actuated or controlled electrically and by compressed air so that various expensive and complicated mechanical means are eliminated and a more efficient, compact and economical feeder is produced.

A further object is to provide a sheet feeder of the pile type which, through the provision of improved suction devices having working strokes of considerable length, is capable of lifting metal or similar stiff and heavy sheets accurately and reliably one after another from the top of a stationary pile thereof, thus advantageously eliminating the pile supporting and raising elevator customarily employed in feeders of this type which would require a very strong and rigid feeder framework to safely support the same and the heavy pile load of metal or other sheets thereon and which, together with the actuating and control means therefor, would complicate the feeder structure and add materially to the cost of the feeder.

Another object is to provide a sheet feeder of improved construction in which metal sheets of magnetic material will be positively bodily lifted singly and in succession from the top of a pile thereof to a predetermined level, and while horizontal feeding movement is bodily imparted to each lifted sheet relative to the pile and until substantially the entire sheet is so advanced, said sheet will be positively held in suspension at said level and spaced clear of the pile.

Still another object is to provide a sheet feeder having improved pneumatically operated suction devices and improved cooperating magnetic devices for respectively lifting metal sheets of magnetic material singly one after another from the top of a pile thereof to a predetermined level, and for effectively holding each lifted sheet by magnetic attraction at said level while forward feeding movement is imparted thereto relative to said pile.

A further object is to provide a sheet feeder of the character and for the purpose above defined wherein the forward feeding movement is imparted to each lifted and magnetically held sheet by improved pneumatically actuated pusher means acting on the rear edge of the sheet.

Another object is the provision, in a sheet feeder of the character and for the purpose above described, of control means whereby the operation of the suction sheet lifting devices to engage and lift each succeeding sheet is under the control of each preceding lifted sheet so that such operation of said suction devices can safely occur only when the preceding sheet has been advanced at last clear of the path of vertical upward movement of the succeeding sheet.

Still another object is the provision, in a sheet feeder of the character and for the purpose above described, of control means whereby the operation of the sheet feeding pusher means can safely occur only after each sheet is lifted by the suction devices and transferred to the magnetic sheet hold-up devices.

The above and further objects and novel features of the invention will more fully appear from the following detailed description when the same is read in connection with the accompanying drawings. It is to be expressly understood, however, that the drawings are for the purpose of illustration only and are not intended as a definition of the limits of the invention.

In the drawings wherein like reference characters refer to like parts throughout the several views:

Fig. 1 is a side elevational view of a sheet feeder embodying the present invention and particularly adapted for feeding relatively large and heavy metal sheets of magnetic material, the suction sheet lifting devices appearing in their actuated lowered positions which they occupy when the topmost sheet of a depleted stationary pile thereof is about to be bodily lifted by said devices subsequent to a preliminary separation of the rear portion of said sheet by the rearmost suction devices;

Fig. 2 is a top plan view of the feeder shown in Fig. 1;

Fig. 3 is a fragmentary vertical transverse sectional view, on an enlarged scale, of the feeder, said view being taken substantially on the line 3—3 of Fig. 2, and certain of the parts having portions thereof broken away for purposes of clearer illustration;

Figs. 4, 5 and 6 are fragmentary vertical longitudinal sectional views, on an enlarged scale, of the feeder, said views being respectively taken substantially on the lines 4—4, 5—5 and 6—6 of Fig. 2;

Fig. 6*a* is a vertical transverse sectional view taken substantially on the line 6*a*—6*a* of Fig. 6;

Fig. 7 is a perspective view with parts broken away and in section illustrating one of the magnetic sheet hold-up devices, one of the suction sheet lifting devices, electrical timing switch means, and a portion of the feed-off conveyor;

Fig. 8 is an enlarged fragmentary elevational view, partly in section, of the air cylinder forming part of each suction sheet lifting device;

Fig. 9 is a horizontal sectional view of one of the suction sheet lifting devices, said view being taken substantially on the line 9—9 of Fig. 5;

Fig. 10 is an enlarged vertical sectional view of one of the sheet gripping suction cups and mounting means therefor;

Fig. 11 is an enlarged vertical transverse sectional view of one of the magnetic sheet hold-up devices;

Fig. 12 is an enlarged front elevational view, partly in section, of the vacuum and vent valve unit shown in Figs. 1 and 2;

Fig. 13 is an enlarged horizontal sectional view of one of the air valves shown in Figs. 1 and 2;

Fig. 14 is a side elevational view, partly in section, of another of the air valves shown in Figs. 1 and 2; and

Fig. 15 is a schematic diagrammatic representation of an electric wiring circuit for the operation and control of the feeder.

Referring now to the drawings, there is shown, by way of example, one form of sheet feeder of the upright pile type constructed in accordance with the present invention, which is particularly adapted for feeding metal sheets **20** of magnetic material in a large variety of sizes and weights successively from the top of a stationary pile **21** thereof to a feed-off conveyor indicated generally at **22** which, in the illustrated embodiment, is of the endless belt type and serves to carry the sheets successively into the machine or instrumentality with which the feeder is associated. As will be seen as the description of the sheet feeder proceeds, said feeder is especially designed to and capable of effectively handling relatively large and heavy metal sheets of magnetic material.

The stationary pile **21** of metal sheets **20** may be safely supported in feeding position in the feeder by any appropriate means which forms no part of the present invention except insofar as it enters into combination with the other elements of the machine. In order to enable convenient loading of the feeder, one such means usually employed for this purpose is a roller conveyor, diagrammatically shown herein for purposes of illustration only and indicated generally at **23** (Fig. 1). This roller conveyor **23** is suitably supported on the feeder foundation and extends from a convenient loading position exteriorly of the feeder to and into said feeder through the rear thereof when rear loading of the feeder is desired as herein shown, or through either open side of the feeder when right-hand or left-hand side loading is desired. The roller or other type of pile loading and supporting conveyor employed is usually of a width which will accommodate the largest sheet that may be handled in the feeder, and is so located within the framework of the feeder and vertically from the feeder foundation that the pile **21** of metal sheets **20** thereon in feeding position will be disposed substantially centrally between the side frames of the feeder, and that the lowermost sheet of said pile will be located within the range of vertical downward movement of long stroke suction sheet lifting devices to be hereinafter described. When the feeder is to be loaded and reloaded through the rear thereof with a pile **21** of metal sheets **20**, the pile is loaded usually by a crane on the outwardly projecting portion of the roller conveyor **23** and then moved on the rollers into the feeder to the position shown in Fig. 1 so that the edges of the sheets **20** facing in the feeding direction are in contact or substantially in contact with front pile guiding means to be hereinafter described. When side loading of the feeder is adopted, the pile **21** of metal sheets **20** is loaded on the roller conveyor **23** such that the front edge of said pile is substantially in transverse alignment with the pile guiding means.

The various movable parts of the feeder as well as certain stationary parts thereof are mounted on a framework consisting of two transversely spaced front uprights **24** and **25**, and two transversely spaced rear uprights **26** and **27** (Figs. 1 and 2). The front uprights **24** and **25** are suitably anchored to the feeder foundation and each is in the form of a flat steel plate **28** (Figs. 1 to 4) having bolted or otherwise suitably secured to the inner surface thereof front and rear upright reinforcing bars **29** and **30**, respectively. The front uprights **24** and **25** are rigidly connected together at the upper ends thereof by front and rear channel cross beams **31** and **32**, respectively, and near the lower ends thereof by a channel cross beam **33**, said cross beams being bolted or otherwise suitably secured to said uprights. The rear uprights **26** and **27** which are in the form of angle members are also suitably anchored to the feeder foundation and they are rigidly connected together at the upper and lower ends thereof and at a selected level intermediate said ends by channel cross beams **34**, **35** and **36**, respectively, which are bolted or otherwise suitably secured to said uprights. The front upright **24** and the rear upright **26** are rigidly connected together by channel side beams **37** and **38** at the upper and lower ends, respectively, thereof, and by a third channel side beam **39** which is located at the same level as that of the rear intermediate cross beam **36**, said side beams being bolted or otherwise suitably secured to said uprights. Likewise, the front upright **25** and the rear upright **27** are rigidly connected together by channel side beams **40** and **41** at the upper and lower ends, respectively, thereof, and by a third channel side beam **42** which is located at the same level as that of the rear intermediate cross beam **36** and the confronting side beam **39**, said side beams **40**, **41**, and **42** being bolted or otherwise suitably secured to said uprights.

The upper cross beam **32** for the front uprights **24** and **25**, and the upper side beam **37** are rigidly connected together by a gusset plate **43** (Fig. 2) bolted or otherwise suitably secured thereto. The upper cross beams **31** and **32** for the front uprights **24** and **25**, and the upper side beam **40** are rigidly connected together by a gusset plate **44** bolted or otherwise suitably secured thereto. The upper side beams **37** and **40**, and the upper cross beam **34** for the rear uprights **26** and **27** are rigidly connected together by gusset plates **45** bolted or otherwise suitably secured thereto. The lower side beams **38** and **41**, and the lower cross beam **35** for the rear uprights **26** and **27** are rigidly connected together by gusset plates **46** bolted or otherwise suitably secured thereto.

It will be apparent that the described elements provide a good strong and rigid feeder framework which is open at the rear between the cross beams **35** and **36**, and at each side between the side beams **38**, **39** and **41**, **42**, respectively, to receive the pile loading and supporting roller conveyor **23**, or other conveyor, and enable rear or side loading of the pile **21** of metal sheets **20** to be fed. For a purpose to be hereinafter described, the upper side beams **37** and **40** have bolted or otherwise suitably secured to the upper faces thereof rack bars **47** (Figs. 1, 2 and 5) which extend substantially the entire length of said side beams. Likewise, the intermediate side beams **39** and **42** have bolted or otherwise suitably secured to the upper faces thereof similar rack bars **48** which extend substantially the entire length of said side beams.

The longitudinal location of the pile **21** of metal sheets **20** in the feeder for proper feeding of the sheets is determined by front pile guiding means in the form of a plurality of transversely spaced vertically disposed plates **49** (Figs. 1, 3 and 4) which are suitably secured to vertically spaced parallel bars **50** and **51** which extend transversely of the feeder between the front uprights **24** and **25** and are bolted or otherwise suitably secured to said uprights. The front pile guides **49** are of a length such that they extend below the upper level of the pile supporting conveyor **23** and above the topmost sheet **20** of a normal full pile **21** shown in broken lines in Fig. 1, and below the upper active reach of the endless feed-off conveyor **22**.

As herein shown, the feed-off conveyor **22** comprises a plurality of rollers **52** and a corresponding plurality of endless belts **53** the rear portions of which pass around said rollers (Figs. 3, 4 and 7). These rollers **52** are fixed in spaced relation on a shaft **54** which extends transversely of the feeder and is journalled at one end thereof in a bearing block **55**, and at the opposite end thereof in a suitable flanged bearing **56**. The bearing **56** is bolted or otherwise suitably secured to the inner surface of a side plate **57** which is bolted or otherwise suitably secured to the inner surface of the front upright **24**. The bearing block **55** is bolted or otherwise siutably secured

to the inner surface of a similar side plate 58 which is bolted or otherwise suitably secured to the inner surface of the front upright 25. The side plates 57 and 58 project forwardly of the feeder, and the forwardly projecting portions thereof are rigidly connected together by a transverse torque tube 59 which is bolted or otherwise suitably secured to said plates. The belts 53 travel over other rollers 60 and 61 which are fixed in spaced relation on spaced parallel shafts 62 and 63, respectively, extending transversely of the conveyor and journalled in suitable flanged bearings 64 and 65, respectively. The bearings 64 are bolted or otherwise suitably secured to the side plates 57 and 58, and the bearings 65 are bolted or otherwise suitably secured to side bars 66 which are bolted or otherwise suitably secured to said plates. The front portions of the belts 53 pass around other rollers (not shown), and the lower reaches of said belts pass over tightening rollers 67 journalled on and at the free ends of arms 68 which are adjustably fixed on a shaft 69 extending transversely of the conveyor and secured at opposite ends thereof against rotation on the side plates 57 and 58. Brackets 70 (Fig. 4) bolted or otherwise suitably secured to the torque tube 59 provide additional supports for the shafts 62 and 69.

The shaft 54, the rollers 52 fixed thereon, and the conveyor belts 53 passing around said rollers are driven continuously and at a desired surface speed so that the metal sheets 20 fed one after another from the top of the plie 21 and delivered to the conveyor 22, as hereinafter described, will be quickly advanced in spaced relation toward the machine or instrumentality with which the feeder is associated. For this purpose, the shaft 54 has fixed thereon adjacent the bearing block 55 a spur gear 71 which meshes with a spur pinion 72 which is fixed on a stub shaft 73 which is journalled in a suitable bearing provided in said block and in a flanged bearing 74 bolted or otherwise suitably secured on the adjacent front upright 25. The pinion 72 has suitably secured thereto a sprocket 75 around which passes a chain 76 which also passes around a smaller diameter sprocket 77 which is fixed on the armature shaft 78 of an electric motor 79. The motor 79 is bolted or otherwise suitably secured to a pair of vertically extending rails 80 which, in turn, are bolted or otherwise suitably secured to the cross bars 50 and 51. Slack in the chain 76 is compensated for by an idler sprocket 81 journalled on and at the free end of an arm 82 which is adjustably fixed on a stud 83 suitably secured in the adjacent side plate 58. The motor 79 which is of the single phase type is supplied with electrical current from a suitable source, and said motor is connected in the electrical control circuit for the feeder for starting and stopping purposes in a manner to be later explained in connection with the description of said circuit.

Disposed directly above the belt rollers 52 on shaft 54 and cooperating with certain of the conveyor belts 53 to insure positive advancing movement of the successive sheets along the conveyor 22 are rubber-tired pressure rollers 84 (Figs. 2, 3, 4 and 7) which are journalled on and at the free rear ends of rearwardly projecting bifurcated arms 85 formed at said ends with rearwardly projecting upwardly curved guide portions 86 for guiding the metal sheets 20 between said pressure rollers and the belts 53. These arms 85 are loosely mounted on a shaft 87 which extends transversely of the conveyor 22 and is journalled at opposite ends thereof in suitable bearings in blocks 88 which are bolted or otherwise suitably secured to the front uprights 24 and 25. Keyed or otherwise suitably fixed on the shaft 87 and disposed between the furcations of each arm 85 is a substantially vertical arm 89 through the apertured upper end of which freely passes the threaded end of a horizontally disposed connecting rod 90 which is pivotally connected at the other end thereof at 91 to and between vertical extensions 92 of the respective arm 85. Each connecting rod 90 has threaded thereon abutment nuts 93 for contacting the respective arm 89 at opposite sides thereof. It will be apparent that by rotating the nuts 93 of the respective pressure roller assemblies in the proper directions the arms 85 may be raised and lowered about the shaft 87 to properly locate the pressure rollers 84 vertically with respect to the belts 53 such that said rollers are spaced from said belts a distance slightly less than the thickness of the metal sheets being handled in the feeder, whereby excessive lifting of the pressure rollers and damage thereto by the sheets is avoided, and prolonged life of said rollers is achieved.

The described pressure roller assemblies are yieldingly urged toward the belts 53 and consequently the pressure rollers 84 are yieldingly pressed against the sheets with sufficient pressure to insure positive advancing movement of the sheets along the conveyor 22. For this purpose, the shaft 87 has fixed thereon adjacent the bearing blocks 88 forwardly projecting arms 94 (Figs. 3 and 4) to the free forward ends of which are pivotally connected the upper ends of externally threaded spring-pressed rods 95 the lower ends of which are slidably guided in suitable clearance openings formed in blocks 96 bolted or otherwise suitably secured to the side plates 57 and 58. The spring for each rod 95 is a coil compression spring indicated at 97 and surrounds said rod between the block 96 and a nut 98 adjustably threaded on the rod and engaging against said spring to adjust the tension thereof. Rotation of the shaft 87 by the expanding action of the springs 97 and consequently downward pivotal movement of the pressure rollers 84 to the described operating positions thereof is limited through engagement of other nuts 99 adjustably threaded on the projecting lower ends of the rods 95 with the lower surface of the respective blocks 96.

The sheets 20 of pile 21 are safely and reliably fed singly one after another from the top of said pile and delivered in like manner to the conveyor 22 for further movement thereby to the machine or instrumentality to be supplied with and acting upon such sheets. This is, in accordance with the present invention, effectively accomplished by engaging the topmost sheet 20 of the pile 21 by suction and lifting first the rear portion of said sheet and then the entire sheet bodily from the pile to a level above the level of the conveyor 22, gripping the sheet 20 by magnetic attraction when the same reaches said conveyor level and and while it is further lifted bodily to the higher level, releasing the suction hold on the sheet at said higher level and lowering said sheet bodily to said conveyor level while it is so magnetically gripped, moving the sheet bodily edgewise in the plane thereof toward said conveyor and between the pressure rollers 84 and conveyor belts 53 while said sheet is so magnetically gripped and held at said conveyor level, and continuing the magnetic gripping action on the sheet until substantially the entire sheet is advanced clear of the pile 21 by said conveyor. The preliminary lifting of the rear portion of each sheet 20, as shown in Fig. 1, is for the purpose of effectively breaking any adhesion between it and the next or underlying sheet of the pile 21, as, for example, when handling sheets which are coated with a film of oil causing said sheets to adhere to each other. This preliminary sheet lifting operation may, however, be eliminated when the feeder is employed to handle only sheets which have no tendency to adhere to each other, thus further simplifying the feeder structure.

Accordingly, the feeder includes suction means for engaging and lifting each sheet 20 in turn from the top of the pile 21, magnetic means to which each lifted sheet is transferred by said suction means for gripping and holding said sheet by magnetic attraction in lifted position and in the plane of the conveyor 22, means for forwarding each lifted, magnetically gripped and positioned sheet relative to the pile 21 and presenting the same to said conveyor, means for controlling the sheet engaging,

lifting and transferring operations of the suction means, and means for controlling the operation of the sheet forwarding means. Each of these means will now be separately described.

As herein shown, particularly in Figs. 1 and 2, for the purpose of lifting the sheets **20** from the top of the pile **21**, first partly at the rear thereof and then completely from said pile, a plurality of improved pneumatically actuated suction devices are employed and arranged so as to engage each sheet at separated points distributed over the entire area of the sheet, whereby a lifting action is afforded which is capable of safety lifting relatively large and heavy metal sheets and each sheet bodily in the existing flatwise condition thereof to a predetermined elevated position without any portion of the sheet slipping or sagging during such lifting movement thereof. Additionally, the suction devices are constructed so that they have working strokes of considerable length, whereby said suction devices are capable of effectively engaging and lifting each and every sheet **20** of the stationary pile **21** from the first or topmost sheet to and including the last or lowermost sheet.

In the illustrated embodiment, eight of said suction sheet lifting devices are employed to engage, grip and lift each sheet at eight widely separated points, but it is to be understood that the number of suction devices employed may be increased or decreased depending upon the maximum size and weight of the sheets to be handled. As herein shown, these suction devices, indicated generally at **100** (Figs. 1, 2, 3, 5, 7, 8 and 9) are arranged in pairs spaced longitudinally of the feeder and mounted for unit adjustment toward and away from each other in accordance with various lengths of sheets being handled and to locate said devices at the desired points with respect to their operation upon longitudinally spaced portions of the sheets **20** at the top of the pile **21**. Additionally, the suction devices **100** of each pair are transversely aligned and mounted for independent adjustment toward and away from each other in accordance with various widths of sheets being handled and to locate said devices at the desired points with respect to their operation upon transversely spaced portions of the sheets **20** at the top of the pile **21**. In the normal operation of the feeder, the first or front pair of suction devices **100** is located inwardly of and near the front edge of the pile **21**, the last or rear pair of suction devices is located inwardly of and near the rear edge of said pile, the remaining pairs of said devices are located at equally spaced points between said front and rear pairs of devices, the four suction devices at one side of the pile are longitudinally aligned and located between the longitudinal center line of said pile and the edge of said pile at said side, and the four suction devices at the other side of the pile are also longitudinally aligned and located between said pile center line and the other side edge of said pile. It will be understood, however, that the location of the suction devices **100** may be varied as desired or required to suit different sheet and pile conditions.

Since the suction devices **100** are identical as respects their construction, mounting and operation, and since the paired mounting of said suction devices is the same for each pair, a detailed description of one of the suction devices and of the mounting of one pair of said suction devices will, therefore, suffice for all of the same. As shown in Figs. 1 and 2, all of the suction devices **100** are indirectly supported by the upper side beams **37** and **40** of the feeder, and each pair of said suction devices is, as shown in Figs. 1, 2, 3 and 5, carried by a separate carriage indicated generally at **101** which is directly supported by said side beams and mounted thereon for sliding movement therealong. Each carriage **101** comprises a square bar **102** which extends transversely of the feeder and has bolted or otherwise suitably secured to opposite ends thereof brackets **103** which slidably rest on the upper faces of the side beams **37** and **40** inwardly of the rack bars **47** on said side beams. Extending transversely of the feeder in spaced parallel relation to the bar **102** is a shaft **104** which is journalled at opposite ends thereof in suitable bearings in the brackets **103** and has fixed thereon at said ends exteriorly of said brackets spur pinions **105** which mesh with the teeth of the rack bars **47**. The shaft **104** has also fixed thereon exteriorly of the pinions **105** and the side beams **37** and **40** hand wheels **106**. Each carriage **101** and the pair of suction sheet lifting devices **100** carried thereby may thus be manually adjusted in either direction lengthwise of the feeder from either side thereof through rotation of the respective hand wheels **106** in the proper direction and meshing engagement of the respective pinions **105** with the rack bars **47**. Each carriage **101** is secured in the desired position of adjustment thereof along the side beams **37** and **40** by T-screws **107** which extend downwardly through suitable clearance openings in the respective brackets **103** and bar **102** and are threaded into clamp plates **108** (Fig. 3) which are disposed beneath said bar and project laterally beneath the upper webs of said side beams. The clamp plates **108** are so formed at the inner ends thereof that they straddle the respective bar **102** to prevent rotation thereof relative to said bar.

Each suction sheet lifting device **100** comprises a relatively long vertically disposed air cylinder **109** (Figs. 1, 3, 5 and 7) which is closed at the upper and lower ends thereof by heads **110** and **111**, respectively, which are held in position and against the respective ends of said cylinder in air-tight relation by four rods **112** and nuts **113**. Slidably mounted within the cylinder **109** is a piston **114** (Fig. 8) which is suitably secured to the upper end of a solid piston rod **115** which projects downwardly through and beyond the lower head **111** of said cylinder. The lower projecting end of the piston rod **115** is reduced in diameter and is threaded to receive a fitting **116** (Fig. 10) to the lower surface of which is firmly attached by means of a headed tubular stem **117** a rubber suction cup **118**. This suction cup **118** is of a relatively large diameter so that distribution of suction on an increased area of the sheet, with resulting increased gripping effect thereon by said cup is obtained. The fitting **116** is provided with an internal passage **119** which communicates with the suction cup **118** through the tubular stem **117** and with a vertically extending rigid conduit **120** which is secured at its lower end to said fitting and extends upwardly therefrom through a suitable clearance opening formed in a guide block **121** which is bolted or otherwise suitably secured to the lower cylinder head **111**. The conduit **120** is movable downwardly and upwardly with the fitting **116** and provides for connecting a source of vacuum to be hereinafter described with the interior of the suction cup **118**. The upper cylinder head **110** has suitably secured therein a tubular elbow fitting **122** which provides for connecting a suitable source of compressed air with the interior of the cylinder **109** above the piston **114** through a passage **123** formed in said head. Likewise, the lower cylinder head **111** has suitably secured therein a tubular fitting **124** which provides for connecting the source of compressed air with the interior of the cylinder **109** below the piston **114** through a passage (not shown) formed in said head.

Each suction sheet lifting device **100** is not only separately mounted for independent adjustment along the respective cross bar **102**, but is also pivotally mounted at the upper end thereof for swinging movement longitudinally and transversely of the pile **21** of sheets **20** under the influence of the sheet engaged thereby so as to enable preliminary separation or lifting of the rear portion of each sheet without said sheet slipping on the suction cups **118**, and to allow for yielding movement of the suction devices by and with the sheet during lifting of said sheet from the pile **21**, whereby slipping of the sheet

on the suction cups 118 is further avoided. For this purpose, the air cylinder 109 of each suction device 100 has bolted or otherwise suitably secured to opposite sides of the upper head 110 thereof vertical plates 125 (Figs. 1, 3, 5 and 7) provided adjacent the upper ends thereof with a horizontal transversely extending bolt or stud 126 which is fixed in said plates and over which is slidably engaged a conventional ball and socket type universal joint 127. Each universal joint 127 extends upwardly from the respective bolt 126 and is adjustably mounted at the upper end thereof, as by nuts 128, in a forwardly projecting horizontal lug 129 formed at the upper end of a vertical upper bracket 130 which is engaged over the cross bar 102 of the respective carriage 101.

Each bracket 130 is held against upward displacement from the respective bar 102 by a lower bracket 131 (Figs. 1, 3, 5, 7 and 9) which is disposed below said bar and is bolted or otherwise suitably secured to said upper bracket. Each lower bracket 131 is formed with interconnected downwardly projecting portions 132 and 133 which are disposed at right angles to each other and extend at the rear and outer sides, respectively, of the respective air cylinder 109. These portions 132 and 133 of each lower bracket 131 have slidably mounted thereon bumper elements in the form of rubber capped spring-pressed studs 134 which are arranged to be engaged by the respective air cylinder 109 to absorb the shock and cushion the return action of the respective suction device 100 when the latter is returned to its original normal position after the sheet lifted thereby is released by the suction cup 118 thereof. Each suction device 100 is yieldingly urged toward and normally held in engagement with the respective bumper elements 134 by a coil extension spring 135 having one end thereof connected to one of the cylinder rods 112 and the opposite end connected to the respective lower bracket 131 substantially at the juncture of the portions 132 and 133 of said bracket, as indicated at 136. The bumper elements 134 are held against complete displacement from the respective bracket 131 by nuts 137 threaded on the outwardly projecting ends of said elements.

It will thus be apparent that each suction device 100 is independently adjustable along the respective cross bar 102, and that by virtue of the described pivotal mounting afforded by the universal joint 127, each suction device is held in suspension above the pile 21 of sheets 20 and is capable of swinging movement longitudinally and transversely of said pile. In the illustrated embodiment, each suction device 100 is secured in the desired position of adjustment thereof along the respective cross bar 102 by a thumb screw 138 which is threaded in the respective upper bracket 130 and engaged with said bar. It will also be apparent that through the provision of pneumatically actuated cylinder and piston type suction devices 100 having relatively long cylinders 109, as previously described and illustrated herein, providing working sheet engaging and lifting strokes of considerable length, all mechanically actuating means therefor are eliminated, elevation of the pile of sheets 21 is unnecessary nor required, and the suction cups 118 are capable of downward movement from their normal retracted uppermost positions an extent sufficient to enable said cups to reliably and effectively grip and lift each and every sheet 20 of the pile 21 including the last or lowermost sheet. For purposes to be hereinafter described, the suction devices 100 are vertically located such that in the normal retracted uppermost positions of the suction cups 118, as shown in Fig. 5, the lower sheet engaging surfaces of said cups are located a short distance above the horizontal plane of the upper active reaches of the conveyor belts 53.

The compressed air supplied to the upper and lower ends of the cylinders 109 of the suction devices 100 is of sufficient pressure to rapidly move the pistons 114 and suction cups 118 downwardly into pressing engagement with the topmost sheet 20 of the pile 21, to rapidly move the pistons, the suction cups and the sheet gripped by said cups upwardly away from said pile, and to enable the lifting of relatively large and heavy metal sheets. It will thus be apparent that when air under pressure is supplied, as hereinafter described, to the upper ends of the cylinders 109 of the suction devices 100 through the fittings 122, the pistons 114 and suction cups 118 are rapidly driven downwardly relative to said cylinders until said suction cups engage the uppermost sheet 20 of the pile 21 under pressure and are completely sealed by said sheet. During such downward movement of the suction cups 118 the latter are connected, as hereinafter described, with a source of vacuum through the conduits 120, fittings 116 and stems 117 so that at the time said cups engage the topmost sheet 20 of the pile 21 at whatever level it may occupy and are sealed by said sheet vacuum is created therein to cause the same to firmly grip the sheet. When the delivery of compressed air to the upper ends of the cylinders 109 is thereafter interrupted and air under pressure is supplied to the lower ends of said cylinders through the fittings 124, the pistons 114 and suction cups 118 are driven upwardly relative to said cylinders to their uppermost positions shown in Fig. 5, whereupon the sheet engaged and gripped by said suction cups is lifted from the pile 21 to a level above the level of the upper surface of the conveyor 22.

The operation of the suction devices 100 is so controlled that the described upward sheet lifting movement of the pistons 114 and suction cups 118 is relatively rapid until said suction cups approach the end of their upward stroke, after which the final upward movement of the pistons and suction cups to their uppermost positions progresses at a relatively slow or cushioned rate. In this manner, the transmission of shocks to the suction cups 118 and the sheet 20 carried thereby is eliminated, a smooth stopping action is imparted to the suction cups, and gentle presentation of each lifted sheet 20 by said suction cups to magnetic sheet hold-up devices, to be hereinafter described, and positive gripping of the sheet by magnetic attraction by said devices is assured. For this purpose, each cylinder 109 is provided therein at the top thereof with a cushion insert 139 having a bore 140 extending vertically therethrough and adapted to slidably receive therein a cushion piston 141 which is spaced upwardly from the upper surface of the main piston 114 by a spacer 142 a distance equal to the length of the insert 139 and is suitably secured to the upper end of the piston rod 115. It will be seen that the main piston 114 and consequently the suction cup 118 will rapidly travel upwardly relative to the cylinder 109 until the cushion piston 141 enters the bore 140 in the insert 139. Thereupon, the rapid upward speed of travel of the piston 114 and suction cup 118 is slowed down and said piston and suction cup are caused to travel at a slow or cushioned speed the remainder of the upward stroke thereof until the piston 114 gently engages the cushion insert 139. It might be mentioned at this time that when the piston 114 is moved downwardly, the air created thereby in the lower end of the cylinder 109 is relieved through the fitting 124, as hereinafter described, and when said piston is moved upwardly, the air created thereby in the upper end of said cylinder is relieved through the fitting 122, as hereinafter described.

Suitable means are provided for creating and breaking vacuum in the suction cups 118 of the sheet lifting devices 100, and as herein shown, said means are preferably mounted on and comprised by the following instrumentalities. Disposed between the front uprights 24 and 25 of the feeder and mounted on and bolted or otherwise suitably secured to the lower cross beam 33 and the lower cross bar 51 is a metal plate 143 (Figs. 3 and 4). Mounted on and adjustably bolted to the plate 143 is an electric motor 144 which is of the single phase type and is supplied with electrical current from

a suitable source. The motor 144 is also connected in the electrical control circuit for the feeder for starting and stopping purposes as later explained in connection with the description of said circuit. The motor 144 has fixed on the projecting end of the armature shaft 145 thereof a V-pulley 146 around which passes a V-belt 147 which also passes around a similar pulley 148 which is fixed on the projecting end of the shaft 149 of a vacuum pump 150 of well-known construction and needing no detailed description herein. The pump 150 is bolted or otherwise suitably secured on the plate 143 and is provided at the vacuum and air sides thereof with line-filters 151 of any suitable construction.

Connected with the line-filter 151 at the vacuum side of the pump 150 is one end of a rigid conduit 152 which extends upwardly from said pump along one side of the feeder frame to the top thereof. A vacuum regulating valve 153 of any suitable construction is disposed in the conduit 152 adjacent the pump 150. The conduit 152 is connected at the upper end thereof by suitable tubular fittings indicated generally at 154 (Figs. 1 and 2) with one side of the body 155 of a normally closed solenoid actuated vacuum valve 156 (Fig. 12). At the side of the valve body 155 directly opposite the connection for the conduit 152 said valve body is secured by a suitable tubular fitting 157 to a header or bracket 158 which is bolted or otherwise suitably secured on a horizontal plate 159 and is formed therein with an elongated vacuum chamber 160 which communicates with said fitting. The valve body 155 is formed therein with a vertical bore 161 which communicates with the vacuum supply conduit 152 through a passage 162 formed in said body and communicating with said conduit, and with the vacuum chamber 160 in the header 158 through the fitting 157 and a passage 163 also formed in said valve body and axially aligned with the passage 162 and communicating with said fitting.

Slidably mounted in the bore 161 of the valve body 155 is a valve slide 164 which is normally disposed in its lowermost position shown in Fig. 12 and is so constructed that in said position the passages 162 and 163 are closed thereby, thus normally interrupting communication between the vacuum supply conduit 152 and the vacuum chamber 160. The described normal passage closing position of the valve slide 164 is determined through engagement of an annular flange 165 formed on the upper end thereof with the top of the valve body 155. The valve slide 164 at the upper end thereof is connected to or formed integrally with the core 166 of a normally deenergized solenoid 167 having conductors 168 and 169 leading therefrom which are connected in the electrical control for the feeder as hereinafter explained. The solenoid 167 is enclosed in and suitably carried by a cap or hood 170 which is suitably fixed on the valve body 155. The core 166 and the valve slide 164 are biased downwardly to their normal positions shown in Fig. 12 by a coil compression spring 171 surrounding said core and having one end thereof engaging against the solenoid 167 and the opposite end engaging against the flange 165.

The vacuum chamber 160 in the header 158 has connected therewith corresponding ends of two rigid conduits 172 and six flexible conduits 173 (Figs. 1 and 2). The rigid conduits 172 extend upwardly and rearwardly from the header 158 and they are connected at their opposite ends by means of flexible conduits 174 with the rigid conduits 120 of the two rearmost suction devices 100. The flexible conduits 173 are connected at their opposite ends with the rigid conduits 120 of the remaining six suction devices 100. The header 158 has also secured thereto by a suitable tubular fitting 175 a normally open solenoid actuated vent valve 176 (Fig. 12). This vent valve 176, except for the construction of the valve slide indicated at 177, is identical in construction and operation with the previously described vacuum valve 156, and have the same reference characters, except that in the case of the identical parts of the vent valve the reference characters are primed. A detailed description of the vent valve 176 is, under these circumstances, therefore unnecessary, except to point out that the bore 161' communicates with the vacuum chamber 160 in the header 158 through the passage 162' and fitting 175, and that the passage 163' which also communicates with said bore opens outwardly to atmosphere through the side of the valve body 155'. The valve slide 177 of the vent valve 176 normally occupies the lowermost position thereof shown in Fig. 12, and said valve slide, as compared to the vacuum valve slide 164, is constructed so that in said position the passages 162' and 163' are opened thereby, thus normally establishing communication between the vacuum chamber 160 in the header 158 and the vent passage 163' and thereby connecting the suction cups 118 to atmosphere through the stems 117, fittings 116, conduits 120, 173, 174, chamber 160, fitting 175 and vent valve 176. The solenoid for the vent valve 176 not shown in Fig. 12, but diagrammatically shown in Fig. 15 and indicated at 167' has leading therefrom conductors 178 and 179 which are connected in the electrical control circuit for the feeder as hereinafter explained. The vent passage 163' of the vent valve 176 opens into a hood 180 of any suitable construction which serves to shield said passage and is secured to the valve body 155' by a tubular fitting 181 threaded into the passage 163'.

The plate 159 on which the header 158 is mounted and which serves as a mounting plate for other valves to be hereinafter described, is spaced above the top of the feeder and extends lengthwise thereof. The plate 159 is bolted or otherwise suitably secured to two transversely spaced longitudinally extending channel beams 182 (Figs. 1, 2 and 5) which are bolted or otherwise suitably secured at opposite ends thereof to short transversely extending channel beams 183 which, in turn, are bolted or otherwise suitably secured to the upper cross beams 32 and 34 of the feeder framework. A strap 184 straddling the beams 182 and bolted or otherwise suitably secured to said beams serves to support the free ends of the rigid conduits 172.

It will thus be apparent that when the solenoid 167 of the vacuum valve 156 is energized, and the solenoid 167' of the vent valve 176 is simultaneously energized, as hereinafter explained in connection with the electrical control circuit for the feeder, the vacuum valve slide 164 and the vent valve slide 177 are simultaneously electrically raised to positions within the respective bores 161 and 161' such that communication is established between the passages 162 and 163 in the vacuum valve body 155 and is broken between the passages 162' and 163' in the vent valve body 155', respectively, thus connecting the vacuum chamber 160 in the header 158 with the vacuum pump 150 and closing said chamber to the atmosphere. Under these conditions vacuum will be created in the suction cups 118 of all of the suction devices 100 to cause said cups to firmly grip the sheet 20 engaged thereby. When the solenoid 167 of the vacuum valve 156 and the solenoid 167' of the vent valve 176 are thereafter simultaneously deenergized, the vacuum valve slide 164 and the vent valve slide 177 are simultaneously lowered by their respective springs to their original positions shown in Fig. 12, thus against closing the vacuum valve 156 and simultaneously opening the vent valve 176. Under these conditions communication between the vacuum pump 150 and the vacuum chamber 160 in the header 158 is interrupted, and said vacuum chamber, the suction cups 118 and all the described fittings and conduits connecting said suction cups with said vacuum chamber are opened to atmosphere, thus breaking vacuum in the suction cups and causing the same to release the sheet gripped thereby.

Although the feeder may include a separate motor-

driven air pump and a compressed air tank connected with said pump for supplying air under pressure to the cylinders 109 of the suction devices 100, and to sheet forwarding pusher means that will be later described, an appropriate source of compressed air is usually available at the establishment where the feeder is installed for operation and this source of compressed air is, in the illustrated embodiment, effectively utilized and connected with the feeder. For this purpose, the feeder includes a rigid conduit 185 (Figs. 1 and 2) which is adapted to be connected at one end thereof with a compressed air tank (not shown) which is supplied by the customer and is located in the vicinity of the feeder and wherein air under high pressure is continuously maintained. This conduit 185 is located at the top of the feeder and has connected therein an air filter 186, an air pressure gauge and regulating device 187 and an air lubricating device 188, all of which may be any well-known construction. The conduit 185 is supported at the air inlet end thereof by a bar 189 which extends across and is bolted or otherwise suitably secured to the beams 182. The conduit 185 is connected at the other end thereof, by suitable tubular fittings indicated generally at 190, with the air intake sides of three solenoid controlled air valves 191, 192 and 193 which are bolted or otherwise suitably secured to the plate 159. The air valve 191 controls the air pressure actuated parts of the two rearmost suction devices 100, the air valve 192 controls the air pressure actuated parts of the remaining six suction devices 100, and the air valve 193 controls the air pressure actuated parts of the sheet forwarding pusher means to be later described.

The air valves 191, 192 and 193 are identical and of a conventional well-known design and a brief description of the construction and operation of one of said air valves will, therefore, suffice for all of the same. For the sake of description, the air valves 191, 192 and 193 have the same reference characters applied thereto, except that in the case of the parts of the valve 192 the reference characters are primed, and in the case of the valve 193 the reference characters are double-primed.

As shown in Fig. 13 which is a horizontal cross sectional view of the air valve 191, said valve comprises, in general, a main casing 194 having end caps or closures 195 and 196, a main spool type valve 197, a ball type pilot valve 198 for controlling the shifting of the main valve, and a solenoid 199 to control the shifting of the pilot valve. The solenoid 199 has conductors 200 and 201 leading therefrom which are connected in the electrical control circuit for the feeder, as hereinafter explained. The solenoids 199' and 199'' of the air valves 192 and 193, respectively, are shown diagrammatically in Fig. 15 and the conductors 200', 201' and 200'', 201'' leading therefrom, respectively, are also connected in the electrical control circuit, as hereinafter explained.

More specifically, the main valve 197 is slidably mounted in a central bore 202 formed in and extending lengthwise through the casing 194. The bore 202 communicates with an air supply chamber 203 through a port 204, and with an air exhaust chamber 205 through two axially spaced ports 206 and 207, said chambers extending lengthwise of the casing 194 and being located at opposite sides of said bore. The bore 202 also communicates with two axially spaced passages 208 and 209 extending vertically through the top of the casing 194. The passage 208 has connected thereto one end of a rigid conduit 210 (Figs. 1 and 2) which is connected at the opposite end thereof by flexible conduits 211 with the fittings 122 connected with and leading to the upper ends of the cylinders 109 of the two rearmost suction devices 100. The passage 209 has connected thereto one end of a rigid conduit 212 which is connected at the opposite end thereof by flexible conduits 213 with the fittings 124 connected with and leading to the lower ends of the cylinders 109 of the two rearmost suction devices 100.

The air supply chamber 203 in the casing 194 is continuously connected to the air pressure supply conduit 185 by the fittings 190, whereas the air exhaust chamber 205 in said casing is continuously connected to the atmosphere through a threaded port 214 in the casing. The air supply chamber 203 continuously communicates at one end thereof with the corresponding end of the valve bore 202 through a passage 215, and said chamber is adapted to communicate at the other end thereof with the other end of said bore through a passage 216 formed in a rubber gasket 217 disposed between the casing 194 and the cap 196 and extending across the chamber 203.

The passage 215 serves to continuously direct the compressed air from the supply chamber 203 into the valve bore 202 against the adjacent end of the valve 197 to shift the latter toward the cap 196 to the full line position thereof shown in Fig. 13 and yieldingly hold said valve in said position which is the position it normally occupies when the solenoid 199 is deenergized. The passage 216 is normally closed by the pilot valve 198, as shown in Fig. 13, through pressure applied by said valve on the gasket 217, thus normally preventing transmittal of compressed air from the supply chamber 203 into the left-hand end of the valve bore 202 and shifting of the valve 197 thereby toward the cap 195. It is to be noted that the area of the valve 197 at the end thereof nearest the cap 196 is larger than that at the other end of said valve so as to enable shifting movement of the valve by compressed air toward the cap 195 in opposition to the air pressure applied against the smaller diameter end of said valve.

Yielding pressure is normally applied against the pilot valve 198 to close the passage 216 by a spring-pressed lever 218 which is pivotally mounted intermediate the ends thereof on the core 219 of the solenoid 199. The solenoid 199 is suitably mounted on the cap 196 in fixed relation, and the core 219 and lever 218 are suitably guided for straight line reciprocating movement relative to said solenoid. A cover 220 engaged over the cap 196 encloses the pilot valve solenoid assembly.

It will thus be seen that with air under pressure continuously present in the chamber 203 of the valve 191, and with the solenoid 199 normally deenergized and the valve 197 normally occupying the full line position thereof shown in Fig. 13, compressed air is normally transmitted from said chamber through the port 204, the passage 209 and the described conduits and fittings connected with said passage to the lower ends of the cylinders 109 of the rearmost suction devices 100, thus normally holding the pistons 114 and the suction cups 118 of said suction devices in their uppermost starting positions. When the solenoid 199 is energized, as hereinafter described, the core 219 and the lever 218 are electrically drawn away from the cap 196, thus releasing the pressure of said lever on the pilot valve 198. Thereupon the compressed air in the chamber 203 forces the pilot valve 198 away from the passage 216 and against the seat therefor in the cap 196, thus closing the exhaust port for said pilot valve in said cap, and permitting the high pressure air to flow through the passage 216 and against the larger diameter end of the valve 197 to shift the latter to the broken line position thereof shown in Fig. 13. Under these conditions, communication between the port 204 and the passage 209 is broken, thus interrupting the delivery of compressed air to the lower ends of the cylinders 109 of the two rearmost suction devices 100, the passage 209 is connected with the exhaust port 207, thus permitting said cylinder ends to exhaust to the atmosphere through the chamber 205 and opening 214 in the casing 194, the exhaust port 206 is blocked by the valve 197, and the port 204 is connected with the passage 208, resulting in the delivery of compressed air, through the described conduits and fittings connected with the passage 208, to the upper ends of the cylinders 109 of the two rearmost suction devices

100 and downward movement of the respective pistons 114 and suction cups 118 in unison until said cups engage the topmost sheet 20 of the pile 21.

When the topmost sheet 20 of the pile 21 is gripped by the suction cups 118 of the two rearmost suction devices 100 and the solenoid 199 is thereafter deenergized, the spring actuated core 219 and lever 218 are released and said lever is caused to again press the pilot valve 198 against the gasket 217 and thereby again close the passage 216 to the chamber 203. This closing of the passage 216 by the pilot valve 198 permits the air pressure against the larger diameter or left-hand end of the valve 197 to exhaust through the exhaust port in the cap 196. Thereupon the constant air pressure against the smaller diameter or right-hand end of the valve 197 acts to shift said valve towards the cap 196 from its broken line position to its full line position shown in Fig. 13. Under these conditions, communication between the port 204 and the passage 208 is broken, thus interrupting the delivery of compressed air to the upper ends of the cylinders 109 of the two rearmost suction devices 100, the passage 208 is connected with the exhaust port 206, thus permitting said cylinder ends to exhaust to the atmosphere through the chamber 205 and opening 214, the exhaust port 207 is blocked by the valve 197, and the port 204 is connected with the passage 209, resulting in the delivery of compressed air to the lower ends of the cylinders 109 of the two rearmost suction devices 100 and upward movement of the respective pistons 114 and suction cups 118 in unison to their uppermost positions and lifting of the sheet 20 from the top of the pile 21.

The air valve 192 which, as previously stated, controls the delivery of compressed air to the other six suction devices 100 functions in the same manner as the air valve 191, as just described. Accordingly, the respective pistons 114 and suction cups 118 of said six suction devices 100 are normally held by compressed air in their uppermost starting positions, and when the solenoid 199' of the valve 192 is energized, the delivery of compressed air to the lower ends of the cylinders 109 is interrupted and air under pressure is simultaneously admitted in the upper ends of said cylinders, thus driving said pistons and suction cups downwardly in unison until the cups engage the uppermost sheet 20 of the pile 21. When the solenoid 199' of the valve 192 is thereafter deenergized, the delivery of compressed air to the upper ends of the cylinders 109 is interrupted and air under pressure is simultaneously admitted in the lower ends of said cylinders, thus driving the pistons 114 and suction cups 118 upwardly to their uppermost positions and, together with the suction cups 118 of the two rearmost suction devices 100, bodily lifting the sheet 20 from the top of the pile 21 to a level above the level of the conveyor 22.

In order to simplify the pneumatic connections between the air valve 192 and the six suction devices 100 controlled thereby, there is provided a header 221 (Fig. 14) which is formed with two non-communicating air chambers 222 and 223. This header 221 is bolted or otherwise suitably secured to a plate 224 which is mounted on top of the casing 194' of the air valve 192. The plate 224 is secured to the valve casing 194' by two externally threaded tubular fittings 225 and 226 which are threaded in the air pressure outlet passages 208' and 209', respectively, in said casing and project upwardly therefrom into the air chambers 222 and 223, respectively, in the header 221 through suitable clearance openings in said plate. The fittings 225 and 226 have threaded thereon nuts 227 which are tightened against the plate 224. The air chamber 222 in the header 221 has connected therewith corresponding ends of six flexible conduits 228 the opposite ends of which are connected with the fittings 124 which are carried by and connected with the lower ends of the cylinders 109 of the six suction devices 100 controlled by the air valve 192. The air chamber 223 in the header 221 has connected therewith corresponding ends of six flexible conduits 229 the opposite ends of which are connected with the fittings 122 which are carried by and connected with the upper ends of the cylinders 109 of the six suction devices 100 controlled by the air valve 192.

It will thus be seen that when the solenoid 199' of the air valve 192 is deenergized and the valve member of said valve occupies an axial position in the casing 194' corresponding to the full line position of the valve member 197 of the air valve 191, as shown in Fig. 13, the air chamber 222 in the header 221 will be connected with the air pressure side of the air valve 192, and the chamber 223 in said header will be connected with the exhaust side of the air valve 192. Accordingly, air under pressure will be transmitted from the chamber 222 to the lower ends of the cylinders 109 of the six suction devices 100 controlled by the valve 192, while permitting the upper ends of said cylinders to exhaust into the chamber 223 and to the atmosphere through the casing 194' of said valve. When the solenoid 199' of the air valve 192 is energized, the air pressure connections are reversed, the air under pressure in this instance being transmitted from the chamber 223 to the upper ends of the cylinders 109 of the six suction devices 100, while permitting the lower ends of said cylinders to exhaust into the chamber 222 and to the atmosphere through the valve casing 194', thus effecting downward movement of the suction cups 118 of said suction devices in unison until said cups engage the topmost sheet 20 of the pile 21. When the solenoid 199' of the air valve 192 is again deenergized following engagement of the suction cups 118 of the six suction devices 100 with the sheet 20 and gripping of said sheet by said cups, the air pressure connections are restored to their original condition, with the result that compressed air is again transmitted from the chamber 222 to the lower ends of the cylinders 109 while permitting the upper ends of said cylinders to again exhaust into the chamber 223, thus effecting upward movement of the suction cups 118 and lifting of the sheet 20 gripped thereby from the pile 21.

It is evident from the above that all of the suction devices 100 are electrically controlled and pneumatically operated. As hereinafter described, the operations of the suction devices 100 are so controlled that the suction cups 118 of all of said devices are moved downwardly in unison into engagement with the top sheet 20 of the pile 21, and when said suction cups have gripped said sheet, the suction cups of the two rearmost suction devices are first moved upwardly to lift the rear portion of the sheet, as shown in Fig. 1, and thereby separate said sheet from the next or underlying sheet on the pile 21. Then, and while the suction cups 118 of the two rearmost suction devices 100 continues to move upwardly to their uppermost positions, the suction cups 118 of the six remaining suction devices 100 are moved upwardly to their uppermost positions, thereby bodily lifting the entire sheet 20 in its flatwise condition thereof from the top of the pile 21, as shown in broken lines in Fig. 1. It will be noted that the extent of separation of the rear portion of the sheet 20 by the two rearmost suction devices 100 may be varied as desired to suit different stock conditions by simply varying the delay period between the upward movement of the suction cups 118 of said devices and the upward movement of the suction cups 118 of the other six suction devices 100. It will also be noted that when handling sheets which have no tendency to adhere to each other, the preliminary separation of the rear portion of each sheet may be eliminated by simply connecting the cylinders 109 of the two rearmost suction devices 100 with the air valve and header unit 192, 221. In this manner, the suction cups 118 of all eight suction devices 100 will be lowered and raised in unison to engage and bodily lift each sheet 20 in turn from the top of the pile 21.

As each sheet 20 is bodily lifted from the top of the pile 21 by the suction cups 118 of the suction devices 100

and approaches the end limit of upward movement of said cups, said sheet is brought into contact with a plurality of magnetic rolls which are arranged to magnetically grip the sheet at separated points distributed over the entire area of said sheet, whereby the entire sheet, when released by the suction cups 118, will be safely held by said magnetic rolls in suspension above the pile 21. The active sheet gripping surfaces of the magnetic rolls are presented downwardly, and said rolls in the normal vertical positions thereof are so disposed that said surfaces are located at a uniform level substantially coplanar with the level of the conveyor 22. Additionally, the magnetic rolls are mounted for upward yielding movement by the lifted sheet 20 so that positive gripping of said sheet by said rolls is assured, and for downward yielding movement with the sheet to the normal positions thereof when said sheet is released by the suction cups 118 to provide for forwarding of the sheet relative to the magnetic rolls and accurate presentation thereof to and between the belts 53 and the pressure rollers 84 of the conveyor 22.

In the illustrated embodiment, eight of the magnetic rolls, indicated generally at 230 (Figs. 1 and 2), are employed to magnetically grip each lifted sheet 20 at eight widely separated points, there being one of said magnetic rolls associated with each suction device 100 and preferably located forwardly of and relatively close to said suction device. It will be understood, however, that the location of the magnetic rolls 230 may be varied as desired or required to suit different sheet conditions, and that the number of magnetic rolls employed may be increased or decreased depending upon the maximum size and weight of the sheets to be handled in the feeder. As shown in Figs. 1 and 2, the magnetic rolls 230 are likewise arranged in pairs and each pair of magnetic rolls is mounted for unit adjustment longitudinally of the feeder to various positions and for independent adjustment toward and away from each other transversely of the feeder to various positions. Since the magnetic rolls 230 are identical as respects their construction, mounting and operation, and since the paired mounting of said magnetic rolls is the same for each pair, a detailed description of one of the magnetic rolls 230 and of the mounting of one pair of said magnetic rolls will, therefore, suffice for all the same.

As best shown in Fig. 11, each magnetic roll 230 is of the permanent magnet type and comprises a sleeve 231 which is made of bronze, brass or other non-magnetic material and is externally threaded at one end thereof and is formed at the other end thereof with a head 232. Loosely engaged over the nonmagnetic sleeve 231 is a cylindrical permanent magnet 233 having a north and south pole as indicated at N and S, respectively. The permanent magnet 233 is interposed between a pair of spaced circular shells 234 and 235 provided with horizontal magnetically attracting sheet engaging rims 236 and 237, respectively, which project toward each other and are spaced apart at their inner ends. The shells 234 and 235 are made of soft iron or any other suitable material which will be magnetized by the permanent magnet 233, and said shells, due to their engagement with opposite ends of said magnet, also have north and south poles which produce a magnetic flux across the rims 236 and 237 and cause each lifted metal sheet 20 to positively adhere to said rims when moved into contact therewith by the suction cups 118 of the suction devices 100. The shells 234 and 235 are slidably keyed to the non-magnetic sleeve 231, and said shells, said sleeve and the permanent magnet 233 are firmly clamped together as a unit by a circular nut 238 made of bronze, brass or other non-magnetic material and threaded on the threaded projecting end of the sleeve. Tightening of the nut 238 presses the shell 234 against the head 232 on the sleeve 231, the permanent magnet 233 against said shell, and the shell 235 against said magnet.

As best shown in Figs. 1, 2, 3, 5 and 7, all of the magnetic rolls 230 are indirectly supported by the intermediate side beams 39 and 42 of the feeder framework, and each pair of said magnetic rolls is carried by a separate carriage indicated generally at 239 which is directly supported by said side beams and mounted thereon for sliding movement therealong. The carriages 239 are identical in construction with the previously described carriages 101 on which the suction devices 100 are mounted and, hence, each carriage 239 comprises a square bar 240 and shaft 241 disposed in spaced parallel relation and extending transversely of the feeder. The bar 240 has bolted or otherwise suitably secured to opposite ends thereof brackets 242 which slidably rest on the upper surfaces of the side beams 39 and 42 inwardly of the rack bars 48 on said side beams. The shaft 241 is journalled at opposite ends thereof in suitable bearings in the brackets 242 and has fixed thereon at said ends and exteriorly of said brackets spur pinions 243 which mesh with the teeth of the rack bars 48. The shaft 241 has also fixed thereon exteriorly of the pinions 243 and the side beams 39 and 42 hand wheels 244 to provide for manual adjustment of the carriage 239 in either direction longitudinally of the feeder from either side thereof. Each carriage 239 is secured in the desired position of adjustment thereof along the side beams 39 and 42 by T-screws 245 extending loosely through the brackets 242 and the cross bar 240 and threaded into clamp plates 246 which are disposed beneath said bar and engage the lower surfaces of the upper webs of said side beams.

The magnetic rolls 230 extend transversely of the feeder to enable rotation thereof by each lifted and gripped sheet 20 as said sheet is forwarded relative to said rolls to the conveyor 22, as hereinafter described, and is further advanced by said conveyor. Additionally, to enable each magnetic roll 230 to adapt itself to the surface contour of each sheet 20 lifted into contact therewith so as to insure contact of both shells 234 and 235 thereof with said sheet, each magnetic roll is mounted for tilting movement in a vertical plane by the sheet. For the described purposes and to provide for independent adjustment of the magnetic rolls 230 transversely of the feeder and independent yielding up and down movement thereof, as previously stated, each magnetic roll 230 is straddled by the lower bifurcated end portion of a vertical bracket 247 (Figs. 3, 5, 7 and 11) and is suitably fixed on a stub shaft 248 which is journalled in suitable bearings provided in said bracket portion. The bracket 247 is mounted at the upper end thereof on a bracket 249 by four bolts 250 which extend loosely through vertical slots 251 formed in the bracket 247 and are threaded in the bracket 249 such that the bracket 247 is free to move up and down relative to the bracket 249, said slots being of a width such that the bracket 247 may also assume an angular position with respect to the bracket 249. The bracket 249 is slidably engaged over the cross bar 240 of the respective carriage 239 and has threaded therein a thumb screw 252 which is engaged with said bar for securing said bracket and the bracket 247 and magnetic roll 230 carried thereby in the desired position of adjustment thereof transversely of the pile 21.

It will thus be seen that the magnetic rolls 230 are independently adjustable along the respective cross bars 240, and that by virtue of the described mountings afforded by the respective bolts 250 and slots 251, said magnetic rolls are independently held in suspension above the pile 21 of sheets 20 and are capable of yielding up and down and tilting movements on the respective carriages 239. In the normal positions occupied by the magnetic rolls 230 with the respective brackets 247 resting by gravity on the respective bolts 250 at the upper ends of the respective slots 251, said magnetic rolls are vertically located such that the lower extremities of the sheet engaging and gripping shells 234, 235 thereof are

disposed in a uniform plane which is a short distance below the plane of the sheet engaging and gripping surfaces of the suction cups 118 in the uppermost positions of said suction cups and is substantially coplanar with the plane of the active upper reaches of the conveyor belts 53, all as shown in Fig. 5. It might be pointed out that the magnetic rolls 230 are mounted on the respective cross bars 240 with alike poles facing each other so that the magnetic force between each pair of rolls is repelling instead of attracting in order to insure magnetic sheet gripping effect of said rolls.

It will thus be apparent that as each sheet 20 is lifted from the top of the pile 21 by the suction cups 118 of the suction devices 100, as hereinbefore described, said sheet will contact the magnetic rolls 230 before it is fully lifted and said suction cups have reached their uppermost positions. Accordingly, the magnetic rolls 230 will yield upwardly under the influence of the sheet until the latter is fully lifted, thus eliminating all possibility of stripping said sheet from the suction cups 118 and dropping of the same back onto the pile 21, and assuring that the sheet will be magnetically gripped and held by said magnetic rolls prior to release thereof by said suction cups. It will also be apparent that when vacuum is thereafter broken in the suction cups 118 to release the lifted magnetically gripped and held sheet 20, the magnetic rolls 230 with said sheet magnetically adhering thereto will immediately drop by gravity to their lowermost positions, thus positioning the sheet substantially at the level of the conveyor 22 to enable proper forwarding of said sheet in the plane thereof to said conveyor and without contacting the suction cups 118.

Each sheet 20 bodily lifted from the top of the pile 21 and transferred to the magnetic rolls 230 by the suction devices 100 is forwarded relative to said magnetic rolls to the conveyor 22 by a pusher device indicated generally at 253 (Figs. 1, 2, 6 and 6*a*) which is arranged at the rear of the feeder and is adapted to engage the rear transverse edge of the sheet and move said sheet forwardly until the leading edge portion thereof passes between the conveyor belts 53 and pressure rollers 84 and extends a short distance beyond said pressure rollers. As best shown in Figs. 6 and 6*a*, the pusher device 253 comprises a vertically disposed sheet engaging and forwarding plate 254 which extends transversely of the feeder and is riveted or otherwise suitably secured to a vertical bar 255. This bar 255 is threadedly mounted on the projecting end of a solid piston rod 256 provided with a piston operating within a horizontally disposed air cylinder 257. The air cylinder 257 is straddled by the lower bifurcated end portion of a vertical bracket 258 and is bolted or otherwise suitably secured at the front and rear head-ends thereof to longitudinal bars 259 disposed at opposite sides of said cylinder and, in turn, bolted or otherwise suitably secured to said bracket. Rotation of the plate 254 relative to the air cylinder 257 is prevented by a horizontal guide rod 260 which is suitably secured at the rear end thereof in the bracket 258 and projects forwardly from said bracket through a suitable clearance opening formed in the bar 255.

The pusher device 253 is mounted on the feeder framework for manual adjustment longitudinally and transversely of the feeder to accommodate different lengths and widths of sheets that may be handled in the feeder and to locate said device at a desired point with reference to the operation of the plate 254 thereof on the rear transverse edge of each lifted and magnetically held sheet 20. The pusher device 253 is preferably located that the plate 254 engages the rear edge of the sheet centrally thereof. For this purpose, the pusher device 253 is mounted on a separate carriage indicated generally at 261 (Figs. 1, 2, 6 and 6*a*) which is also mounted on the intermediate side beams 39 and 42 for sliding movement therealong and is identical in construction with the previously described carriages 101 and 239. Accordingly, the carriage 261 comprises a square bar 262 and a shaft 263 disposed in spaced parallel relation and extending transversely of the feeder. The bar 262 has bolted or otherwise suitably secured to opposite ends thereof brackets 264 which slidably rest on the side beams 39 and 42 inwardly of the rack bars 48 on said side beams. The shaft 263 is journalled at opposite ends thereof in suitable bearings in the brackets 264 and has fixed thereon at said ends and exteriorly of said brackets spur pinions 265 which mesh with the teeth of the rack bars 48. The shaft 263 has also fixed thereon exteriorly of the pinions 265 and the side beams 39 and 42 hand wheels 266 to provide for manual adjustment of the carriage 261 along the side beams 39 and 42. The carriage 261 is secured in the desired position of adjustment thereof along the side beams 39 and 42 by T-screws 267 which extend loosely through the brackets 264 and the bar 262 and are threaded into clamp plates 268 which are disposed beneath said bar and engage the upper webs of said side beams.

The bracket 258 of the pusher device 253 is engaged at the upper end thereof over the bar 262 of the carriage 261 and is held against displacement from said bar by a top plate 269 which is bolted or otherwise suitably secured to said bracket. The pusher device 253 is secured in the desired position of adjustment thereof along the bar 262 by a thumb screw 270 threaded in the cover plate 269 and tightened against said bar.

Delivery of compressed air to either end of the air cylinder 257 of the pusher device 253 to advance and retract the pusher plate 254 in the process of forwarding each lifted and magnetically held sheet 20 is controlled by the air valve 193. For this purpose, the air pressure outlet passage in the casing 194'' of the air valve 193 corresponding to the passage 209 in the casing 194 of the air valve 191 has connected therewith one end of a rigid conduit 271 (Fig. 1) which is connected at the opposite end thereof with the front end of the air cylinder 257 by a flexible conduit 272 and a tubular fitting 273 (Figs. 6 and 6*a*). Likewise, the air pressure outlet passage in the casing 194'' of the air valve 193 corresponding to the passage 208 of the air valve 191 has connected therewith one end of a rigid conduit 274 the opposite end of which is connected with the rear end of the air cylinder 257 by a flexible conduit 275 and a tubular fitting 276. The rigid conduits 271 and 274, as well as the rigid conduits 210 and 212 previously described, are supported at their free ends by the strap 184.

It will thus be apparent that the pusher plate 254 is normally held in its retracted position, shown in Figs. 1 and 6, by compressed air normally admitted into the front end of the air cylinder 257. When the solenoid 199'' of the air valve 193 is energized, as hereinafter described, the delivery of compressed air to the front end of the air cylinder 257 is interrupted and simultaneously therewith said cylinder end is connected to exhaust to the atmosphere through the valve casing 194'' and air under pressure is admitted into the rear end of said cylinder, thus driving the pusher plate 254 forwardly into engagement with the rear edge of the lifted and magnetically held sheet 20 and moving said sheet forwardly in the plane thereof relative to the magnetic rolls 230 to and between the conveyor belts 53 and the cooperating pressure rollers 84 for further movement thereby to the machine or instrumentality with which the feeder is associated. When the solenoid 199'' of the air valve 193 is thereafter deenergized, the delivery of compressed air into the rear end of the air cylinder 257 is interrupted and simultaneously therewith said cylinder end is connected to exhaust to the atmosphere through the valve casing 194'' and air under pressure is again admitted into the front end of said cylinder, thus driving the pusher plate 254 rearwardly and returning the same to its normal position in readiness to act on the next sheet. It might be pointed out that the air cylinder 257 is provided at

opposite ends thereof with the usual adjustable throttle screws indicated at 277 for controlling the speed of forward and reverse movements of the pusher plate 254.

It is to be noted that during advancing movement of each sheet by the conveyor 22 the magnetic rolls 230 continue to magnetically hold the trailing portion of the sheet in raised position until a major portion of said sheet is advanced beyond the front vertical projection of the pile 21. In order to silence the air exhausted from the cylinders 109 of the suction devices 100 through the casings 194 and 194' of the air valves 191 and 192, respectively, and from the cylinder 257 of the pusher device 253 through the casing 194" of the air valve 193, during the operation of the feeder, the exhaust port in the valve casing 194' corresponding to the exhaust port 214 in the valve casing 194 has threaded therein a silencer 278 of any well-known construction, and the exhaust port 214 in the valve casing 194 and the corresponding exhaust port in the valve casing 194" are connected together by a rigid conduit 279 in which is disposed a similar silencer 280 of any well-known construction (Fig. 1).

The feeder is provided with a sheet calipering or excess sheet detecting mechanism, indicated generally at 281 (Figs. 3 and 4), which is constructed and mounted in a novel manner and is associated with the conveyor 22 to caliper each sheet presented thereto and to cause a control action of the feeder, such as stopping of said conveyor and further feeding of sheets 20 from the pile 21, in the event a sheet 20 presented to the conveyor is accompanied by or contains an additional sheet.

As herein shown, the sheet calipering mechanism 281 comprises a bracket 282 which is bolted or otherwise suitably secured to the cross bar 50 substantially centrally thereof and contains an anti-friction bearing 283 for centrally supporting and providing frictionless rotation of the driven belt roller shaft 54. Journalled on a laterally projecting hub of the bracket 282 or on a laterally projecting sleeve carried by said bracket is a lower sheet calipering roller 284 which is in the form of an anti-friction ball bearing and is substantially of the same diameter as the diameter of the belt rollers 52 including the belts 53 passing around said belt rollers. The calipering roller 284 is retained on the described hub or sleeve by a disc 285 which is engaged over and is suitably secured to the shaft 54. If desired, the calipering roller 284 may be driven from the shaft 54 in unison with and at the surface speed of the belts 53 by drivably connecting the disc 285 with said roller. The calipering roller 284 is thus supported independently of the shaft 54 for free and true concentric rotation, and the bore of the hub or sleeve on which said roller is mounted is preferably slightly greater in diameter than that of the shaft 54 so that any vibration of said shaft and any variation in the concentricity thereof will not be transmitted to the calipering roller 284 and affect the sheet calipering operation.

Cooperating with the lower calipering roller 284 and disposed above the path of sheet travel is an upper sheet calipering roller 286 (Figs. 3 and 4) which is journalled on and at the free end of one arm 287 of a bell crank lever 288 the other arm of which is indicated at 289. The arms 287 and 289 of the bell crank lever 288 projects downwardly and forwardly, respectively, of the pivotal axis of said lever, and the latter is pivotally mounted on a stud 290 which is suitably secured in a vertically disposed longitudinally extending plate 291. This plate 291 is mounted for vertical up and down adjustment on and relative to an angle bar 292 by bolts 293 which extend loosely through suitable clearance openings in superposed blocks 294 and 295 and have threaded thereon nuts 296 which engage the blocks 295. The blocks 294 and 295 are bolted or otherwise suitably secured to the plate 291 and angle bar 292, respectively. The plate 291 and the bell crank lever 288 and other parts carried by said plate are secured in any desired position of vertical adjustment on the angle bar 292 by bolts 297 which extend loosely through suitable vertical slots 298 in said plates and are threaded in said angle bar. The angle bar 292 is bolted or otherwise suitably secured to the upper front cross beams 31 and 32 of the feeder framework.

The arm 289 of the bell crank lever 288 has adjustably threaded in the free end thereof a contact element 299 (Fig. 4) in the form of a bolt which is held in adjusted position by a lock nut 300. This contact element or bolt 299 is adapted to engage the plunger 301 of a normally open micro-switch 302 having conductors 303 and 304 leading therefrom which are connected in the electrical control circuit for the feeder, as hereinafter explained. The micro-switch 302 is suitably secured to the plate 291. A coil extension spring 305 connected at one end thereof to the arm 289 of the bell crank lever 288 and at the opposite end thereof to the plate 291 tends at all times to yieldingly urge said bell crank lever in a clockwise direction about its pivot 290, as viewed in Fig. 4, and thereby yieldingly hold the upper calipering roller 286 in sheet calipering position and the contact element 299 in engagement with the plunger 301 of the micro-switch 302. The described pivotal movement of the bell crank lever 288 by the spring 305 is limited through engagement of the arm 289 of said lever with an abutment member 306 in the form of a bolt which is adjustably threaded in a block 307 which is suitably secured on the plate 291.

The abutment member or bolt 306 is adjusted with respect to the bell crank arm 289 such that the upper calipering roller 286 is disposed directly above the lower calipering roller 284. Following this, the contact element or bolt 299 on the bell crank arm 289 is adjusted with respect to the micro-switch 302 such that the plunger 301 of said switch is normally depressed by said contact element sufficiently to close the contacts of the switch, as diagrammatically illustrated in Fig. 15. Following this, the upper calipering roller 286, through upward or downward adjustment of the plate 291, is vertically adjusted with respect to the cooperating lower calipering roller 284 such that a space equal to the normal thickness of a single sheet 20 is left between said rollers.

It will thus be apparent that as long as single sheets 20 are delivered to the conveyor 22 and pass between the calipering rollers 284 and 286 during the normal operation of the feeder, nor rocking movement will be imparted to the bell crank lever 288 in a counterclockwise direction (Fig. 4) by the single sheets. Accordingly, the plunger 301 of the switch 302 will not be released by the contact element 299, said switch will remain closed and the feeder will continue to operate in the normal usual manner. However, should a sheet 20, for some reason, be accompanied by or contain another or excess sheet 20 adhering thereto as it passes between the calipering rollers 284 and 286, the bell crank lever 288 will be rocked in a counterclockwise direction (Fig. 4) by the double or plural sheets sufficiently to cause the contact element 299 to release the plunger 301 of the switch 302, thus permitting the contacts of said switch to automatically open. Opening of the contacts of switch 302 breaks the control circuit in which said switch is connected, resulting in stopping of the conveyor 22 to prevent delivery of the double sheet to the machine to be fed, as well as interruption of the feed of additional sheets 20 from the pile 21 in a manner to be hereinafter described.

Since the pneumatic operations of the suction sheet lifting devices 100 and of the sheet pusher device 253 are electrically controlled, as evident from the foregoing description, electrical switch means are necessarily provided to effect such operations. Although the feeder may, for this purpose, include a continuously driven single revolution shaft having switch actuating cams thereon for cyclically effecting the pneumatic operations of the suction devices 100 and the pusher device 253 in proper

timed relation, an untimed normally inoperative electrical multi-circuit timer of conventional design is employed for this purpose in order to further simplify the construction and operation of the feeder. This timer, to be presently described in connection with Fig. 15, is of the type known as Polyflex Reset Timer, sold by Eagle Signal Corporation, and is mounted at a convenient point on the feeder framework and is under the control of auxiliary switch means responsive to the absence of a sheet 20 from the magnetic rolls 230 and from the path of upward movement of the sheets fom the top of the pile 21. Thus, in the illustrated embodiment, the feeding of sheets 20 from the top of the pile 21 is initially started when a master switch is placed by the operator in closed position, and each feeding cycle is thereafter initiated only after a preceding outgoing sheet 20 has been advanced by the conveyor 22 sufficiently so that the trailing edge thereof is at least clear of the front vertical projecton of the pile 21. In this manner, lifting of each succeeding sheet 20 by the suction devices 100 from the top of the pile 21 to the magnetic rolls 230 is safely assured without interference or obstruction by the preceding outgoing sheet, and the fed sheets will follow each other along the conveyor 22 in a desired closely spaced procession.

Referring now to Fig. 15 wherein there is shown, somewhat schematically, an electrical control circuit for the various and sundry instrumentalities hereinbefore described of the feeder, a main source of 110 volt alternating current is connected to vertical power lines P1 and P2 through closing of a main switch S. The control circuit includes certain controlling relays which are designated by the symbol CR with an appropriate numerical suffix for each relay. The contacts controlled by each relay have the same reference character applied thereto with an appropriate capital letter suffix for each contact. The contacts of the various relays and switches are shown in the positions assumed before the main switch S is closed.

The power line P1 is connected by a branch conductor 310 with one terminal of a manual normally open On switch 311 of the push-button type. This switch 311 is mounted on the front panel of a control box (not shown) which is mounted at a convenient point on the feeder frame, such as on the front upright 24, and contains the various relays and certain other switches and elements to be hereinafter referred to. The other terminal of switch 311 is connected by a conductor 312 with one terminal of a manual normally closed Off switch 313 of the push-button type which is separately mounted on the feeder frame, such as on the front upright 25. The other terminal of switch 313 is connected by a conductor 314 to one terminal of one pair of normally closed contacts 315 of a manual double-pole double-throw Stop switch 316 of the push-button type, the other pair of contacts of said switch being also normally closed and indicated at 317. This switch 316 is also mounted on the control panel. The other terminal of contacts 315 of switch 316 is connected by a conductor 318 to a holding relay CR1 which is directly connected to the power line P2 by a branch conductor 319. The contacts controlled by this relay CR1 are normally open and indicated at CR1A and CR1B. One terminal of the contacts CR1A of relay CR1 is connected to the conductor 318 by a conductor 320, and the other terminal of said contacts is connected by a conductor 321 to the pump motor 144 which is directly connected to the power line P2 by a branch conductor 322. One terminal of the contacts CR1B of relay CR1 is directely connected by a branch conductor 323 to the power line P1, and the other terminal of said contacts is connected by a conductor 324 to the conductor 312.

It will thus appear that when the machine attendant, with the main switch S closed, closes the On switch 311 the relay CR1 is energized, thereby closing the contacts CR1A and CR1B. Closing of the contacts CR1A starts the pump motor 144 in operation. As soon as the pump motor 144 is started, as described, the machine attendant releases the switch 311, thus permitting said switch to open and break the circuit between the conductors 310 and 312. However, the holding relay CR1 continues to receive current from the power line P1 through the conductor 323, the closed contacts CR1B, and the conductor 324 and, hence, the pump motor 144 will continue to run and drive the vacuum pump 150 so long as the Off switch 313 or the Stop switch 316 is not opened by the machine attendant.

The previously described caliper switch 302 is of the double-throw type providing separate contacts 325 and 326 which are arranged so that when one is open the other is closed. In the normal sheet calipering position of the caliper bell crank lever 288, as shown in Fig. 4, the contacts 325 of switch 302 are held closed by the plunger contacting element 299, and consequently the contacts 326 of said switch are held in opened position. One terminal of the contacts 325 of switch 302 has connected thereto the previously described conductor 303 which, in turn, is connected to the conductor 324. The conductor 303 has connected thereto a conductor 327 which is connected to one terminal of the contacts 326 of switch 302. The other terminal of the contacts 326 has connected thereto a conductor 328 which is connected to a signal light 329 which is directly connected to the power line P2 by a branch conductor 330. The signal light 329 is conveniently mounted on the control panel and while it is normally extinguished, its purpose is to become illuminated and thereby indicate visually when the caliper 281 has detected the presence of plural sheets 20 simultaneously fed from the pile 21 and passed between the calipering rollers 284 and 286.

The other terminal of the contacts 325 of switch 302 has connected thereto the previously described conductor 304 which is also connected to one terminal of one pair of normally open contacts 331 of a manual double-pole double-throw Run switch 332 of the push-button type, the other pair of contacts of said switch being normally closed and indicated at 333. This switch 332 is also mounted on the control panel. The other terminal of the contacts 331 of switch 332 is connected by a conductor 334 with one terminal of the contacts 317 of the switch 316. The other terminal of the contacts 317 is connected by a conductor 335 to a second holding relay CR2 which is directly connected to the power line P2 by a branch conductor 336. The contacts controlled by this relay CR2 are normally open and indicated at CR2A and CR2B. One terminal of the contacts CR2A of relay CR2 is connected to the conductor 335 by a conductor 339, and the other terminal of said contacts is connected by a conductor 340 to the motor 79 which drives the conveyor 22 as hereinbefore described. The motor 79 is directly connected to the power line P2 by a branch conductor 341. One terminal of the contacts CR2B of relay CR2 is connected to the conductor 304 by a conductor 342, and the other terminal of said contacts is connected by a conductor 343 to the conductor 334.

It will thus be apparent that when the machine attendant, after starting the pump motor 144 through closing of the On switch 311 as previously described, then actuates the Run switch 332 to connect the conductors 304 and 334, the relay CR2 will be energized, thereby closing the contacts CR2A and CR2B. Closing of the contacts CR2A starts the conveyor motor 79 in operation. As soon as the conveyor motor 79 is started, the machine attendant releases the switch 332, thus breaking the circuit between the conductors 304 and 334. However, the relay CR2 continues to receive current from the power line P1 through the conductor 323, the closed contacts CR1B of relay CR1, the conductor 303, the

closed contacts 325 of the caliper switch 302, the conductors 304 and 342, the closed contacts CR2B of relay CR2, and the conductor 343. Accordingly, the conveyor motor 79 will continue to run and drive the conveyor belts 53 so long as the Off switch 313 or the Stop switch 316 is not opened by the machine attendant, and so long as single sheets 20 only are fed from the pile 21 and delivered to the conveyor 22. In the event a sheet 20 fed from the pile 21 and delivered to the conveyor 22 is accompanied by or contains an excess sheet 20 adhering thereto, resulting in actuation of the caliper bell crank lever 288 and opening of the contacts 325 of the switch 302, the previously described current for maintaining the relay CR2 energized is broken thus causing said relay to be deenergized so that the contacts CR2A and CR2B are again opened and the motor 79 and consequently the conveyor 22 is stopped. When the excess sheet 20 is thereafter removed from the conveyor 22 accompanied by pivotal movement of the caliper bell crank lever 288 to its original normal position and closing of the contacts 325 thereby, the conveyor motor 79 may again be started by actuating the switch 332 to momentarily close the contacts 331 thereof to again energize the relay CR2.

The contacts 333 of the switch 332 serve to connect the power line P1 with the electrical timer hereinbefore referred to. It is to be noted that when the switch 332 is actuated by the machine attendant to close the contacts 331 thereof and start the conveyor motor 79, the contacts 333 of said switch are opened. Accordingly, the electrical timer cannot be energized until the conveyor motor 79 has been started and the switch 332 has been released by the machine attendant. As schematically shown in Fig. 15, the electrical timer includes a motor 345, a clutch (not shown) which is engaged by a solenoid to connect said motor with a cam shaft 346, the coil of said solenoid being shown and indicated at 347, a series of cams 348, 349, 350, 351, 352 and 353 on said cam shaft, and a corresponding series of switches 354, 355, 356, 357, 358 and 359 arranged to be actuated by said cams, respectively, all said elements being enclosed within a suitable casing. As also well known, the timer includes spring means (not shown) for resetting the cams 348 to 353, inclusive to their original starting or zero positions, shown in Fig. 15, after the clutch is disengaged and the motor 345 is stopped at the end of each timing cycle. It is to be noted that in the normal starting position of the stopped timer shaft 346, the switch 354 is normally closed by the cam 348, and the switches 355, 356, 357, 358 and 359 are normally open in readiness to be closed in unison by the respective cams 349, 350, 351, 352 and 353 immediately upon rotation of the timer shaft 346.

The electrical circuit for the timer, and the various circuits controlled by said timer, comprises the contacts 333 of switch 332 and a conductor 360 which is connected to one terminal of said contacts and to the previously described conductor 343. The other terminal of the contacts 333 has connected thereto a conductor 361 which is connected to one terminal of a manual normally open Start-Stop switch 362 that is also mounted on the control panel. The other terminal of this switch 362 is connected by a conductor 363 to one terminal of a normally closed switch 364 the other terminal of which is connected by a conductor 365 to one terminal of a second normally closed switch 366.

As best seen in Figs. 5 and 7, the switches 364 and 366 are of the well-known roller lever arm actuator type. The switches 364 and 366 are suitably secured to angle brackets 367 and 368, respectively, which are mounted in tandem relation on and adjustable along a bar 369 which extends longitudinally of the feeder. The bar 369 and consequently the switches 364 and 366 carried thereby are located at the front and preferably at one side of the feeder in close proximity to the foremost suction device 100 and magnetic roll 230 at said side and above the plane of the sheet engaging surface of the suction cup 118 in the uppermost position of said cup. The bar 369 is bolted or otherwise suitably secured to the lower end of a vertical bracket 370 which is engaged at the upper end thereof over the cross bar 240 of the foremost carriage 239 and is held against displacement from said bar by a top plate 371 that is suitably secured to said bracket. The bracket 370 is secured in the desired position of adjustment thereof on the bar 240 by a thumb screw 372 which is threaded in the plate 371 and tightened against said bar.

The angle bracket 367 supporting the normally closed switch 364 has pivotally mounted thereon at 373 (Figs. 5 and 7) a cam block 374 which is engaged with the roller 375 of said switch. The cam block 374 normally occupies the position thereof shown in Fig. 7 so that the roller 375 of the switch 364 is normally disposed in the low part of the cam surface on said block to enable actuation of said roller and opening of said switch by said cam block, as hereinafter explained. The cam block 374 is biased to the described normal position thereof by a light coil extension spring 376 having one end thereof connected to said cam block and the opposite end connected to the angle bracket 367. Pivotal movement of the cam block 374 by the spring 376 to the normal position thereof is limited through engagement of said block with an adjustable abutment in the form of a machine screw 377 which is threaded in a block 378 suitably secured to the angle bracket 367 and is locked in adjusted position by a lock nut 379. Excess pivotal movement of the cam block 374 in the opposite direction out of engagement with the roller 375 of the switch 364 is prevented by a stop pin 380 which is suitably secured in the angle bracket 367. The cam block 374 has suitably secured thereto a feeler finger 381 which extends forwardly and downwardly at an angle from said block. The length of the feeler finger 381 is so chosen that with the cam block 374 in its normal switch closing position shown in Fig. 7, and with the suction cups 118 of the suction devices 100 in their uppermost positions, the lower free end of said finger projects below the horizontal plane of the sheet engaging surfaces of said cups.

In the normal operation of the feeder, the angle bracket 367 is located on the bar 369 so that the feeler finger 381 occupies a position rearwardly of the front pile guides 49 and preferably that the lower free end of said finger is positioned between the adjacent suction device 100 and associated magnetic roll 230. Accordingly, as each sheet 20 is lifted from the top of the pile 21 by the suction devices 100 as hereinbefore described, the feeler finger 381 is engaged and raised by said sheet, thus rocking the cam block 374 in a counterclockwise direction, as viewed in Fig. 7, substantially to the position thereof shown in Fig. 5 and thereby causing the high part of the cam surface on said block to engage and raise the roller 375 and open the switch 364. Opening of the switch 364 breaks the circuit including said switch and the switch 366 so that at the end of one cycle of operation of the electrical timer the latter will be automatically stopped and reset for a repeat performance under the control of the switches 364 and 366, as hereinafter explained.

The angle bracket 368 which supports the second normally closed switch 366 has also pivotally mounted thereon at 382 (Figs. 5 and 7) a similar a cam block 383 which is engaged with the roller 384 of said switch. The cam block 383 normally occupies the position thereof shown in Fig. 7 so that the roller 384 of the switch 366 is normally disposed in the low part of the cam surface on said block to enable actuation of said roller and opening of said switch by said cam block, as hereinafter explained. The cam block 383 is biased to the described normal position thereof by a light coil extension spring

385 having one end thereof connected to said block and the opposite end connected to the angle bracket 368. Pivotal movement of the cam block 383 to the normal position thereof by the spring 385 is limited through engagement of said block with an abutment member in the form of a machine screw 386 which is adjustably threaded in a block 387 suitably secured to the angle bracket 368 and is locked in adjusted position by a lock nut 388. Excess pivotal movement of the cam block 383 in the opposite direction out of engagement with the roller 384 of the switch 366 is prevented by a stop pin 389 suitably secured in the angle bracket 368. The cam block 383 has also suitably secured thereto a feeler finger 390 which extends forwardly and downwardly at an angle from said block.

In the normal operation of the feeder, the feeler finger 390 is located in line with the space between two of the conveyor belts 53, and the angle bracket 368 is located on the bar 369 so that said feeler finger occupies a position forwardly of the front pile guides 49 and preferably extends beyond the conveyor belt rollers 52 and cooperating pressure rollers 84, as shown in Fig. 5. The length of the feeler finger 390 is so chosen that with the cam block 383 in its normal switch closing position shown in Fig. 7, the lower free end of said finger will project below the upper reaches of the conveyor belts 53. Accordingly, as each sheet 20 lifted from the pile 21 by the suction devices 100 and forwarded to the conveyor 22 by the pusher device 253 is advanced by the conveyor belts 53 and cooperating pressure rollers 84, the feeler finger 390 is engaged and raised by said sheet, thus rocking the cam block 383 in a counterclockwise direction, as viewed in Fig. 7, substantially to the position thereof shown in Fig. 5 and thereby causing the high part of the cam surface on said block to engage and raise the roller 384 and open the switch 366.

As will hereinafter appear, when the switch 366 is opened by the advancing sheet 20 as described, the circuit including said switch, the switch 364, and the timer switch 354 will remain broken notwithstanding that the switch 364 will again be closed as soon as the support for the feeler finger 361 previously afforded by said sheet is no longer present and said feeler finger falls to its original lowermost position under the contracting action of the spring 376, and that the timer switch 354 will again be closed when the timer is reset at the end of a timing cycle. Accordingly, opening of the switch 366 delays a repeat operation of the electrical timer and the lifting of the next succeeding sheet 20 from the pile 21 until the preceding sheet has not only been safely advanced clear of the pile but has been further advanced along the conveyor 22 beyond the feeler finger 390. As the advancing sheet on the conveyor 22 passes out of engagement with the feeler finger 390 said finger will fall to its original lowermost position by the contracting action of the spring 385 with the result that the switch 366 will again be closed. Closing of the switch 366 restores the circuit including said switch, thus initiating another cycle of operation of the electrical timer and the lifting of the next succeeding sheet 20 from the pile 21.

Proceeding now with the description of the electrical circuit for the timer, and the various circuits controlled by said timer, the other terminal of the second sheet controlled switch 366 is, as shown in Fig. 15, connected by a conductor 391 to one terminal of the cam actuated timer switch 354. The other terminal of the timer switch 354 is connected by a conductor 392 to the timer motor 345 which is directly connected to the power line P2 by a branch conductor 393. The conductor 392 has connected thereto a conductor 394 which is connected to one terminal of the cam actuated timer switch 355 the other terminal of which is connected by a conductor 395 to a conductor 396 which, in turn, is connected to the previously described conductor 363. The timer clutch operating coil 347 is connected to the conductors 393 and 394 by conductors 397 and 398, respectively.

The conductor 200 leading from the solenoid 199 of the air valve 191 is connected directly to the power line P2, and the other conductor 201 leading from said solenoid is connected to one terminal of the cam actuated timer switch 356. The other terminal of the timer switch 356 is directly connected to the power line P1 by a branch conductor 399. The conductor 200' leading from the solenoid 199' of the air valve 192 is connected directly to the power line P2, and the other conductor 201' leading from said solenoid is connected to one terminal of the cam actuated timer switch 357. The other terminal of the timer switch 357 is connected by a conductor 400 to the conductor 399. The conductor 169 leading from the solenoid 167 of the vacuum valve 156 is directly connected to the power line P2, and the other conductor 168 leading from said solenoid is connected to one terminal of the cam actuated timer switch 358. The other terminal of the timer switch 358 has connected thereto the power line P1. The conductor 179 leading from the solenoid 167' of the vent valve 176 is directly connected to the power line P2, and the other conductor 178 leading from said solenoid is connected to the conductor 168.

One terminal of the cam actuated timer switch 359 has connected thereto the previously described conductor 396, and the other terminal of said timer switch has connected thereto a conductor 401 which is connected to a relay CR3 which is directly connected to the power line P2 by a conductor 402. The contacts controlled by this relay CR3 are normally closed and indicated at CR3A. One terminal of the contacts CR3A of relay CR3 has connected thereto the conductor 201'' leading from the solenoid 199'' of the air valve 193. The other conductor 200'' leading from this solenoid 199'' connects the power line P2 with said solenoid. The other terminal of the contacts CR3A of relay CR3 has connected thereto a conductor 403. This conductor 403 is connected to one terminal of a normally open switch 404 which may be termed a safety switch and which is coupled to the sheet controlled switch 364 so that when the switch 364 is opened by a lifted sheet 20 the switch 404 is closed. The other terminal of the switch 404 is connected by a conductor 405 to one terminal of a normally open switch 406 the other terminal of which has connected thereto a conductor 407 which is connected to the conductor 396.

In the present instance, the switch 406 is preferably mounted on the machine with which the feeder is associated and to which the sheets 20 are successively advanced by the conveyor 22. The switch 406 is actuated to closed condition by a cam 408 which is also mounted on the machine to be fed and which is suitably driven to make one revolution for each cycle of operation of said machine so that the operation of the pusher device 253 and the forwarding of each lifted and magnetically held sheet 20 thereby to the conveyor 22 is effectively and reliably controlled by said machine to insure delivery of the sheets thereto at proper timed intervals. The feeding of the sheets 20 successively from the pile 21 will thus proceed at regularly spaced intervals and said sheets will follow each other along the conveyor 22 spaced a predetermined distance apart. The time interval between the feeding of successive sheets 20 from the pile 21 and consequently the spacing of the sheets on the conveyor 22 may be varied by simply changing the longitudinal position of the feeler finger 390 with respect to the conveyor 22.

It will be understood that the switch 406 may be manually actuated by the machine attendant stationed at the machine being fed so that the sheets 20 are successively presented to said machine as needed. Additionally, the timer cam 353 and the described control circuit may be modified so that the operation of the pusher device 253

and, hence, the forwarding of each lifted and magnetically held sheet 20 thereby is effected at the proper time upon closing of the timer switch 359 by said cam. Also, the described switch 406 may be mounted on the feeder and actuated in many ways such as, for example, by the lifted and magnetically held sheet or by any one of the magnetic roll units when said sheet is lowered to and reaches the plane of the conveyor 22.

It will thus be apparent that with the control circuit herein illustrated and described, when the machine attendant, after starting the pump motor 144 and the conveyor motor 79 through closing of the switches 311 and 332, respectively, as previously described, now actuates the Start-Stop switch 362 to connect the conductors 361 and 363, the timer motor 345 and the timer clutch coil 347 are simultaneously energized, thus starting said motor and connecting the same with the timer cam shaft 346. Immediately upon rotation of the timer cam shaft 346 by the timer motor 345, the timer switch 354 will remain closed under the control of the cam 348, and the timer switches 355, 356, 357, 358 and 359 will be closed in unison by the respective cams 349, 350, 351, 352 and 353. The timer cam 349 controls the duration of operation or a timing cycle of the timer and upon closing of the timer switch 355 by said cam, the timer motor 345 and the timer coil 347 will continue to receive current through the conductors 396 and 395, switch 355 and conductor 394 until the timer has completed one timing cycle regardless of the opening of switch 364 by the lifted sheet 20 prior to the completion of said cycle.

Upon closing of the timer switches 356 and 357 by the respective cams 350 and 351, the solenoids 199 and 199′ of the air valves 191 and 192, respectively, are simultaneously energized and as a consequence thereof the suction cups 118 of all of the suction devices 100 are pneumatically driven downwardly in unison until said cups engage the top sheet 20 of the pile 21. Upon closing of the timer switch 358 by the cam 352, the solenoids 167 and 167′ of the vacuum valve 156 and vent valve 176, respectively, are simultaneously energized, thus opening said vacuum valve and closing said vent valve and as a consequence thereof vacuum is created in the suction cups 118 of all of the suction devices 100 during downward movement of said cups to cause the latter to grip the top sheet 20 of the pile 21 upon contact of the same with said sheet. Upon closing of the timer switch 359 by the cam 353, the relay CR3 is energized, thus opening the contacts CR3A. Opening of the relay contacts CR3A insures that the circuit to the solenoid 199″ of the air valve 193 which controls the pusher device 253 is broken during the operation of the suction devices 100 and the lifting of the top sheet 20 thereby from the pile 21 and until such time that said sheet is positioned by the magnetic rolls 230 in the plane of the conveyor 22, thus guarding against accidental or premature operation of said pusher device.

As the timer shaft 346 continues to rotate, the timer switches 355 and 356 are opened in succession in the order named and as a consequence thereof the solenoids 199 and 199′ of the air valves 191 and 192, respectively, are deenergized in like order. Accordingly, upward movement of the suction cups 118 of the two rearmost suction devices 100 is first initiated, following which the upward movement of the suction cups 118 of the remaining suction devices 100 is initiated. Under these conditions, the top sheet 20 of the pile 21 is first lifted at the rear thereof a predetermined degree by the two rearmost suction devices 100 to break the adhesion between it and the next or underlying sheet, and then said top sheet is lifted bodily by all of the suction devices 100 to the uppermost positions of the suction cups 118 and presented in a substantially horizontal position to the magnetic rolls 230.

As the top sheet 20 of the pile 21 is lifted by the suction devices 100 to the uppermost positions of the suction cups 118, the feeler finger 381 is engaged and raised by said sheet, thus opening the switch 364 and breaking the circuit between the conductors 363 and 365. However, the timer will continue to receive current through the closed timer switch 355 and, hence, said timer will continue to function. Immediately after the top sheet 20 is lifted by the suction devices 100 to the uppermost positions of the suction cups 118, the timer switch 358, through continued rotation of the timer shaft 346, is caused to open and as a consequence thereof the solenoids 167 and 167′ are simultaneously deenergized, thus closing the vacuum valve 156 and opening the vent valve 176. Under these conditions, vacuum in the suction cups 118 of all the suction devices 100 is broken and said cups are opened to atmosphere, thus causing the suction cups to release and transfer the lifted sheet 20 to the magnetic rolls 230. Thereupon the magnetic rolls 230 with the lifted sheet 20 magnetically adhering thereto drop by gravity to their lowermost positions, thereby positioning said sheet substantially in the plane of the conveyor 22 for forward movement thereof to said conveyor by the pusher device 253.

At about this time, the timer switches 354 and 359, through continued rotation of the timer shaft 346, are opened. Opening of the timer switch 354 breaks the circuit between the conductors 391 and 392, thus temporarily disconnecting the sheet controlled switches 364 and 366 from the timer for the remaining portion of the timing cycle. Opening of the timer switch 359 deenergizes the relay CR3, thus causing the contacts CR3A of said relay to close and thereby connect the conductors 403 and 201″. Immediately after the relay CR3 is deenergized and the contacts CR3A thereof are closed, as described, the machine cam 408 functions to close the switch 406, whereupon the solenoid 199′ of the air valve 193 is energized and as a consequence thereof the pusher plate 254 is pneumatically actuated to engage the rear edge of the lifted and magnetically held sheet 20 and push said sheet forwardly to and between the conveyor belts 53 and the cooperating pressure rollers 84. It will be noted that when the switch 364 is opened by the lifted sheet 20, the switch 404 is simultaneously closed, thus providing for operation of the pusher plate 254, as described, through closing of the machine switch 406, and enabling such operation only after the sheet has been lifted and positioned in the plane of the conveyor 22.

Immediately after opening of the timer switch 359 to deenergize the relay CR3 and thereby provide for operation of the pusher device 253, as described, the timer switch 355 is opened through continued rotation of the timer shaft 346. Opening of the timer switch 355 completes one timing cycle of the timer and breaks the circuit including said switch. Since at this time the switch 364 is being held in opened condition by the advancing sheet 20, and the timer switch 354 is open, the circuit including said switches and the switch 366 is broken and, hence, opening of the timer switch 355 stops the timer motor 345 and simultaneously deenergizes the timer clutch coil 347. Thereupon, the timer shaft 346 is disconnected from the stopped timer motor 345, and the timer cams 348, 349, 350, 351, 352 and 353, through reverse rotation of said shaft by suitable spring means, are reset to their original or starting positions with the timer switch 354 again closed by the cam 348 to provide for the next operation of the timer and the lifting of the next sheet 20 from the top of the pile 21 which obviously will occur as soon as both feeler fingers 381 and 390 are released by the preceding advancing sheet and the respective switches 364 and 366 are again closed thereby. After the lifted and magnetically held sheet 20 has been forwarded to the conveyor 22 by the pusher plate 254, the machine switch 406 is again opened by the machine cam 408, whereupon the solenoid 199″ of the air valve 193 is deenergized and as a consequence thereof the pusher plate 254 is pneumatically retracted

to its original position in readiness for operation on the next sheet. Following this, the switch **404** is again opened through release of the feeler finger **381** and the closing of switch **364** thereby.

It is evident that when the switch **313** or the switch **316** is opened by the machine attendant, the pump motor **144** and the conveyor motor **79** are stopped, and the caliper and timer circuits are broken, thus interrupting the operation of the timer if not already normally stopped and discontinuing the sheet feeding and conveying operations of the feeder. When the caliper switch **325** is opened upon actuation of the caliper bell crank lever **288**, the conveyor motor **79** is stopped, and since the timer circuit at this time is normally broken and the timer is idle, opening of the caliper switch will have no affect on the timer circuit. When the switch **362** is opened by the machine attendant, the timer circuit only is broken.

The operation of the sheet feeder constructed in accordance with the present invention will be clearly understood from the foregoing description, and while said description and the accompanying drawings set forth with more or less particularity one embodiment of the invention, it is to be expressly understood that said invention is not limited to said embodiment. It will be apparent that various substitutions and changes in the design and arrangement of the parts illustrated, as well as in the mode of operation, assembly and manner of use, some of which have been mentioned in the foregoing specification, may be made by those skilled in the art without departing from the spirit and scope of the invention. The sheet feeder of the present invention may be employed for the feeding of metal sheets of a non-magnetic character, as well as cardboard and other sheets of relatively stiff non-metallic material by simply substituting other known types of mechanical devices such as, for example, suction wheels or rolls, for the magnetic sheet hold-up rolls herein illustrated and described. For a definition of the limits of the invention, reference is had primarily to the appended claims.

What is claimed is:

1. In a sheet feeder for feeding metal and similar stiff sheets one after another from a pile thereof, the combination of a plurality of suction devices mounted above the pile and arranged so as to act on the topmost sheet of said pile at separated points distributed substantially over the entire area of said sheet, means for reciprocating said suction devices to cause the same to engage and bodily lift the topmost sheet from said pile to a predetermined elevation, a plurality of freely rotatable means mounted above the pile and constructed to receive and grip the upper surface of the lifted sheet at spaced points distributed substantially over the entire area of said sheet surface so as to hold the entire sheet substantially flatwise in suspension above said pile when released by said suction devices, and pusher means mounted and operated to engage one of the edges of the lifted and suspended sheet and impart a forwarding movement to said sheet relative to said rotatable means.

2. Sheet feeding apparatus as defined in claim 1 wherein said means for reciprocating said suction devices includes means to move said suction devices downwardly in unison into engagement with the topmost sheet of the pile and means to move the suction devices located adjacent an edge of said sheet upwardly prior to the upward movement of the remainder of said suction devices, whereby preliminary separation of the topmost sheet from the next or underlying sheet of the pile is obtained prior to lifting of the topmost sheet bodily from said pile by said suction devices.

3. Sheet feeding apparatus as defined in claim 1 adapted to feed sheets of a magnetic character and wherein said rotatable means are in the form of relatively short magnetic rolls spaced longitudinally and transversely of the lifted sheet and disposed with their lower extremities in a common horizontal plane and with their axes parallel to said pusher means.

4. Sheet feeding apparatus as defined in claim 3 wherein said magnetic rolls are of the permanent magnet type.

5. Sheet feeding apparatus as defined in claim 3 wherein said magnetic rolls are disposed with their axes extending transversely of the lifted sheet, and said pusher means is arranged to engage a transverse edge of said sheet.

6. Sheet feeding apparatus as defined in claim 3 wherein said magnetic rolls and the suction sheet lifting devices are so relatively located vertically that the lower extremities of said magnetic rolls are normally disposed below the horizontal plane of the sheet engaging surfaces of said suction devices in the uppermost positions thereof, whereby said magnetic rolls will be engaged by the lifted sheet before the latter and said suction devices reach the limit of upward movement thereof, and comprising means supporting said magnetic rolls and providing for yielding upward movement thereof by the sheet, said magnetic rolls with the lifted sheet magnetically gripped thereby dropping to their normal positions when said sheet is released by said suction devices.

7. Sheet feeding apparatus as defined in claim 3, comprising means supporting said magnetic rolls and providing for inclination of the same by the lifted sheet upwardly in opposite directions from the horizontal in the plane of the axes of said magnetic rolls.

8. In a sheet feeder for feeding sheets of a magnetic character successively from a pile thereof, the combination of a plurality of suction devices mounted above the pile and arranged so as to act on the topmost sheet of said pile at longitudinally and transversely spaced points distributed substantially over the entire area of said sheet, pneumatically actuated means for reciprocating said suction devices to cause the same to engage and bodily lift the topmost sheet from said pile to a predetermined elevation, a plurality of relatively short freely rotatable magnetic rolls mounted above the pile to receive and magnetically grip the upper surface of the lifted sheet at longitudinally and transversely spaced points distributed substantially over the entire area of said sheet surface so as to magnetically hold the entire sheet substantially flatwise in suspension above said pile when released by said suction devices, and pusher means mounted and pneumatically operated to engage one of the edges of the lifted and suspended sheet parallel to the axes of said magnetic rolls and impart a forwarding movement to said sheet relative to said magnetic rolls.

9. In a sheet feeder for feeding sheets of a magnetic character successively from a pile thereof, the combination of a plurality of suction devices mounted above and spaced longitudinally and transversely of the pile so as to act on the topmost sheet of said pile at separated points distributed substantially over the entire area of said sheet, compressed air actuated means for reciprocating said suction devices to cause the same to engage and bodily lift the topmost sheet from said pile to a predetermined elevation, a plurality of relatively short freely rotatable magnetic rolls mounted above and spaced longitudinally and transversely of said pile and disposed with their lower extremities in a common horizontal plane and with their axes extending transversely of said pile, said magnetic rolls acting to receive and magnetically grip the upper surface of the lifted sheet at separated points distributed substantially over the entire area of said sheet surface so as to magnetically hold the entire sheet substantially flatwise in suspension above said pile when released by said suction devices, and compressed air actuated pusher means arranged to engage the rear edge of the lifted and suspended sheet and impart a forwarding movement to said sheet relative to said magnetic rolls.

10. In a sheet feeder for feeding sheets of a magnetic character successively from a pile thereof, the combination of means for bodily lifting the sheets in turn from the top of said pile, said means comprising a plurality

of vertically disposed stationary cylinders, and suction sheet lifting elements having piston stems extending into said cylinders and provided therein with piston heads, said cylinders being arranged to provide for engagement of said suction elements with the topmost sheet of said pile at longitudinally and transversely spaced points distributed substantially over the entire area of said sheet, means for pneumatically reciprocating said suction elements causing them to engage and bodily lift the topmost sheet from said pile to a predetermined elevation, operable valve means for controlling the operation of said suction elements, operable valve means for controlling the making and breaking of vacuum in said suction elements in timed relation with the operation of said suction elements, a plurality of relatively short freely rotatable magnetic rolls located above and spaced longitudinally and transversely of said pile and disposed with their lower extremities in a common horizontal plane and with their axes extending transversely of said pile, said magnetic rolls acting to receive and magnetically grip the upper surface of the lifted sheet at separated points distributed substantially over the entire area of said sheet so as to magnetically hold the entire sheet substantially flatwise in suspension above said pile when released by said suction elements, means for forwarding the lifted and suspended sheet relative to said magnetic rolls and comprising, a horizontally disposed stationary cylinder located rearwardly and substantially in the plane of the lifted and suspended sheet, and a vertically disposed pusher member having a piston stem extending into said cylinder and provided therein with a piston head, means for pneumatically reciprocating said pusher member causing it to engage the rear edge of the lifted and suspended sheet and impart a forwarding movement thereto relative to said magnetic rolls, and operable valve means for controlling the operation of said pusher member in timed relation with the release of the lifted sheet by said suction elements.

11. Sheet feeding apparatus as defined in claim 10 wherein said suction sheet lifting elements and said sheet pusher member are reciprocated by compressed air, and said first-named and last-named valve means function to respectively connect a source of compressed air alternately with opposite ends of the cylinders of said suction elements and the cylinder of said pusher member.

12. Sheet feeding apparatus as defined in claim 10 wherein the arrangement of the cylinders of the suction sheet lifting elements includes at least two cylinders spaced transversely of the pile and disposed for operation of the suction elements thereof on the rear portion of the topmost sheet adjacent the rear edge thereof, and said first-named valve means comprises a first valve pneumatically connected with said two cylinders and a second valve pneumatically connected with the remainder of said cylinders, and comprising means for operating said first and second valves and for controlling the operation thereof such that all of the suction elements are actuated downwardly in unison into engagement with said sheet and upward movement of the two rear suction elements is initiated prior to upward movement of the remainder of said suction elements, whereby preliminary separation of the rear portion of the topmost sheet from the next or underlying sheet on the pile is obtained prior to lifting of said topmost sheet bodily from said pile.

13. Sheet feeding apparatus as defined in claim 10, comprising conveyor means arranged to receive the forwarded sheet and further advance the same relative to and out of engagement with said magnetic rolls and beyond the latter and said pile, single action means operative to effect actuation of said first, second and last-named valve means, means for initially inaugurating the operation of said single action means, and means engaged and actuated by the sheet lifted from the pile by said suction elements for limiting the operation of said single action means to a single operation and operable through advancing movement of said sheet by said conveyor means out of engagement therewith for initiating a subsequent operation of said single action means.

14. Sheet feeding apparatus as defined in claim 13, comprising means associated with said conveyor means and arranged to be engaged and actuated by the advancing sheet for delaying said subsequent operation of said single action means until said sheet has been advanced out of engagement with said last-named sheet engaged means and the latter is released thereby.

15. Sheet feeding apparatus as defined in claim 10 wherein said cylinders of said suction sheet lifting elements are constructed to provide working strokes of said suction elements of a length sufficient to enable projection of said suction elements to at least the lowermost sheet of a stationary non-elevated pile and lifting of each and every sheet in turn from said stationary pile including the last sheet.

16. Sheet feeding apparatus as defined in claim 10, comprising means supporting the cylinders of said suction sheet lifting elements at the upper ends thereof and providing for pivotal movement of said cylinders longitudinally and transversely of the pile under the influence of the sheet engaged and lifted by said suction elements.

17. Sheet feeding apparatus as defined in claim 16 wherein said supporting means comprises a fixed bracket for each cylinder and a universal joint connection connecting said cylinder with said bracket and carried by and adjustable vertically with respect to said bracket.

18. Sheet feeding apparatus as defined in claim 16, comprising bumper means associated with each cylinder and arranged to be engaged by said cylinder in the vertical position thereof, and biasing means acting upon each cylinder and at all times urging the same toward vertical position and into engagement with the bumper means associated therewith.

19. Sheet feeding apparatus as defined in claim 10, comprising means disposed within the cylinders of said suction sheet lifting elements for checking the speed of upward movement of said suction elements as the same approach the limit of upward movement thereof and for causing said suction elements to thereafter move slowly to said limit.

20. Sheet feeding apparatus as defined in claim 10, wherein said magnetic rolls are vertically located such that the lower extremities of said magnetic rolls are normally disposed below the horizontal plane of the sheet engaging surfaces of said suction sheet lifting elements in the uppermost positions thereof, whereby said magnetic rolls will be engaged by the lifted sheet before said sheet and said suction elements reach the limit of upward movement thereof, and comprising means supporting said magnetic rolls and providing for yielding upward movement thereof by said sheet.

21. Sheet feeding apparatus as defined in claim 10, comprising means supporting the cylinders of said suction sheet lifting elements and providing for adjustment of said cylinders and said suction elements to various positions longitudinally and transversely of said apparatus, means supporting said magnetic rolls and providing for adjustment thereof to various positions longitudinally and transversely of said apparatus, and means supporting the cylinder of said sheet pusher member and providing for adjustment of said cylinder and said sheet pusher member to various positions longitudinally and transversely of said apparatus.

22. Sheet feeding apparatus as defined in claim 10, comprising conveyor means arranged to receive the forwarded sheet and further advance the same relative to and out of engagement with said magnetic rolls and beyond the latter and said pile, an electric motor for continuously driving said conveyor means, means for supplying current to said motor and comprising a circuit therefor, and sheet calipering means associated with said con-

veyor means and arranged adjacent the sheet receiving end thereof, said sheet calipering means comprising a lower rotatable sheet calipering roller over which the sheet forwarded to and advanced by said conveyor means is adapted to pass, a bracket mounted above said conveyor means for vertical adjustment downwardly toward and upwardly away from said conveyor means, a bell crank lever mounted on said bracket for pivotal relative movement about a horizontal transverse axis, said bell crank lever providing one arm extending downwardly from said axis and another arm extending forwardly from said axis, an upper rotatable sheet calipering roller journalled on the said one arm and directly overlying said lower sheet calipering roller, said upper sheet calipering roller through vertical adjustment of said bracket being positioned such that it is normally spaced from said lower sheet calipering roller a distance not less than the thickness of said sheet, a normally open switch connected in said circuit and mounted on said bracket below the said another arm of said bell crank lever, resilient means acting on said bell crank lever to yieldingly urge the said another arm toward said switch, and an adjustable abutment mounted on said bracket and engaged by said bell crank lever to limit pivotal movement thereof by said resilient means to a normal position in which said switch is engaged and normally closed by the said another arm to maintain said circuit and continued operation of said motor and said conveyor means, said bell crank lever upon pivotal movement thereof by and through passage of plural sheets simultaneously between the lower and upper sheet calipering rollers causing the said another arm thereof to release said switch to open and thereby break said circuit and stop said motor and said conveyor means.

23. In a sheet handling machine having a conveyor for advancing sheets successively presented thereto along a predetermined horizontal path, sheet calipering means associated with said conveyor for detecting the presentation of plural sheets simultaneously thereto and affecting an electrical control circuit to cause a desired control function of said machine, said sheet calipering means comprising a lower rotatable sheet calipering roller over which the sheets presented to and advanced by said conveyor are adapted to pass, a bracket mounted above said conveyor for vertical adjustment toward and away from said conveyor, a bell crank lever mounted on said bracket for relative pivotal movement about a horizontal transverse axis, said bell crank lever providing one arm extending downwardly from said axis and a second arm extending horizontally from said axis, an upper rotatable sheet calipering roller journalled on the said one arm and directly overlying said lower sheet calipering roller, said upper sheet calipering roller through vertical adjustment of said bracket being positioned such that it is normally spaced from said lower sheet calipering roller a distance not less than the thickness of said sheets, a switch connected in said circuit and mounted on said bracket below said second arm, resilient means acting on said bell crank lever to yieldingly urge the said second arm toward said switch, and an adjustable abutment mounted on said bracket and engaged by said bell crank lever to limit pivotal movement thereof by resilient means to a normal position in which said switch is engaged and actuated by said second arm, said bell crank lever upon pivotal movement thereof by and through passage of plural sheets simultaneously between said lower and upper sheet calipering rollers causing said second arm thereof to release said switch and thereby permit self-actuation of said switch to affect said control circuit and cause the desired control function of the machine.

24. In sheet feeding apparatus for feeding sheets of a magnetic character successively from a pile thereof, the combination of suction devices for lifting the sheets in turn from the top of said pile to a predetermined elevation, conveyor means, means for forwarding the lifted sheets in turn to said conveyor means, means disposed above each lifted sheet for magnetically attracting said sheet and holding the same in suspension above said pile during forwarding movement thereof to said conveyor means and while the same is being advanced by said conveyor means, said last-named means comprising a plurality of magnetic elements spaced longitudinally and transversely of the lifted sheet and normally disposed with their lower extremities in a common horizontal plane below the horizontal plane of the sheet engaging surfaces of said suction devices in the uppermost position thereof, and means individually supporting said magnetic elements and providing for yielding upward movement thereof by each sheet lifted from said pile by said suction devices.

25. The method of feeding sheets of a magnetic character one after another from a pile thereof to a machine or instrumentality acting upon such sheets which comprises, gripping the topmost sheet of the pile by suction and lifting said sheet from said pile to a predetermined elevation, gripping the lifted sheet by magnetic attraction when it reaches a predetermined level below said elevation and continuing the magnetic gripping action on said sheet during continued lifting thereof to said elevation, releasing the suction hold on the lifted sheet at said elevation while it is so magnetically gripped, lowering the released sheet from said elevation to said level while it is so magnetically gripped, moving the released and lowered sheet at said level while it is so magnetically gripped edgewise relative to the pile an extent less than the length of said pile, further advancing the sheet edgewise relative to the pile, and continuing the magnetic gripping action on the advancing sheet until substantially the entire sheet is advanced clear of the pile.

26. The method of feeding sheets of a magnetic character one after another from a pile to a machine or instrumentality acting upon such sheets which comprises, gripping the topmost sheet of the pile by suction at a plurality of longitudinally and transversely spaced points distributed substantially over the entire area of said sheet and lifting the sheet bodily from said pile to a predetermined elevation, gripping the lifted sheet by magnetic attraction at a plurality of longitudinally and transversely spaced points distributed substantially over the entire area of said sheet when the latter reaches a predetermined level below said elevation and continuing the magnetic gripping action thereon during continued lifting of the entire sheet to said elevation, releasing the suction hold on the lifted sheet at said elevation while it is so magnetically gripped, magnetically holding the released lifted sheet in substantially flatwise condition and lowering said sheet in said condition from said elevation to said level, moving the released and lowered sheet at said level while it is so magnetically held edgewise relative to the pile an extent less than the length of said pile, further advancing the sheet edgewise relative to the pile, and continuing the magnetic holding action on the advancing sheet until substantially the entire sheet is advanced clear of the pile.

27. The method as defined in claim 26, comprising the initial step of lifting the rear portion of the topmost sheet from the pile by suction before said sheet is bodily lifted from said pile to said elevation.

28. The method of feeding sheets of a magnetic character one after another from a pile thereof and presenting said sheets to a conveyor for further movement thereby to a machine or instrumentality acting upon such sheets, said method comprising the steps of gripping the topmost sheet of the pile by suction at a plurality of longitudinally and transversely spaced points distributed substantially over the entire area of said sheet and lifting the sheet bodily from said pile to a predetermined elevation spaced above the level of the conveyor, gripping the lifted sheet by magnetic attraction at a plurality of longitudinally and transversely spaced points distributed substantially over the entire area of said sheet

when the latter reaches substantially said conveyor level and continuing the magnetic gripping action on the sheet during continued lifting thereof bodily to said elevation, releasing the suction hold on the lifted sheet at said elevation while it is so magnetically gripped, magnetically holding the released lifted sheet in substantially flatwise condition and lowering said sheet in said condition bodily from said elevation to substantially said conveyor level, moving the lowered sheet at said level while it is so magnetically held edgewise relative to the pile to said conveyor, and continuing the magnetic holding action on the sheet until substantially the entire sheet is advanced clear of the pile by said conveyor.

29. The method as defined in claim 28 wherein edgewise movement of the sheet to the conveyor is effected by engaging the rear edge of said sheet, and comprising the initial step of lifting the rear portion of the topmost sheet from the pile before said sheet is bodily lifted to said elevation.

References Cited in the file of this patent

UNITED STATES PATENTS

2,218,484	Schneider	Oct. 15, 1940
2,338,050	Nelson et al.	Dec. 28, 1943
2,353,214	Bobst	July 11, 1944
2,805,856	Stuchbery	Sept. 10, 1957