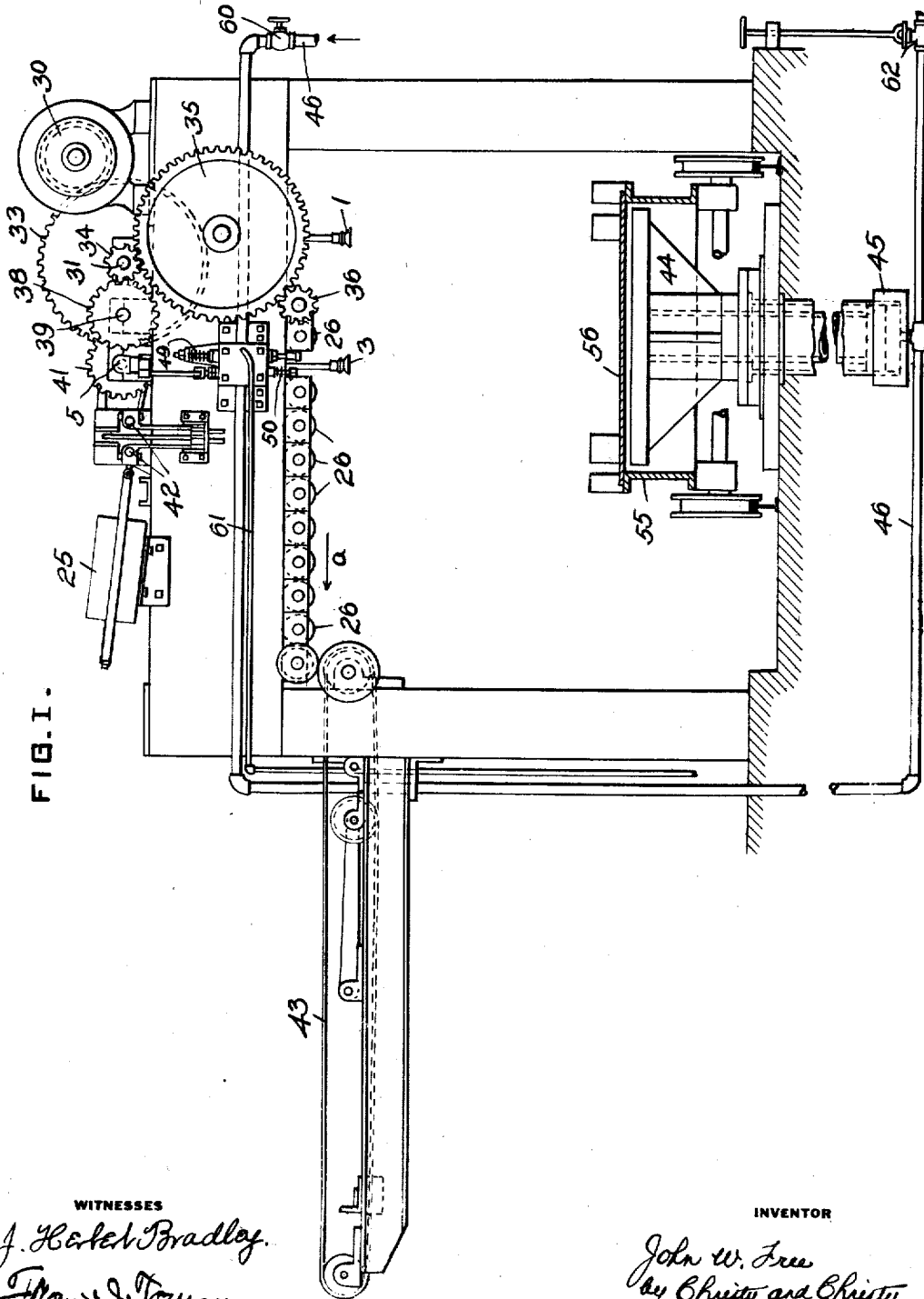


Jan. 16, 1923.

J. W. FREE.
CONVEYER.
FILED MAR. 4, 1920.

1,442,718

6 SHEETS-SHEET 1



WITNESSES
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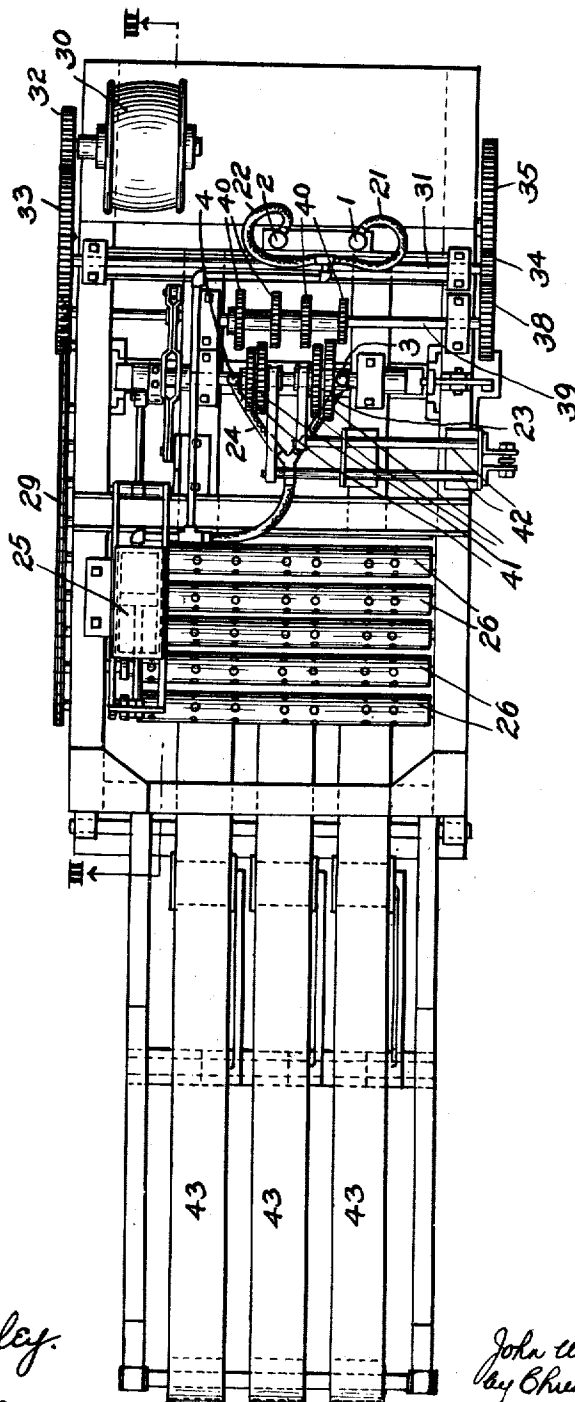
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CONVEYER.
FILED MAR. 4, 1920.

6 SHEETS-SHEET 2

FIG. II -



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1,442,718

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6 SHEETS-SHEET 3

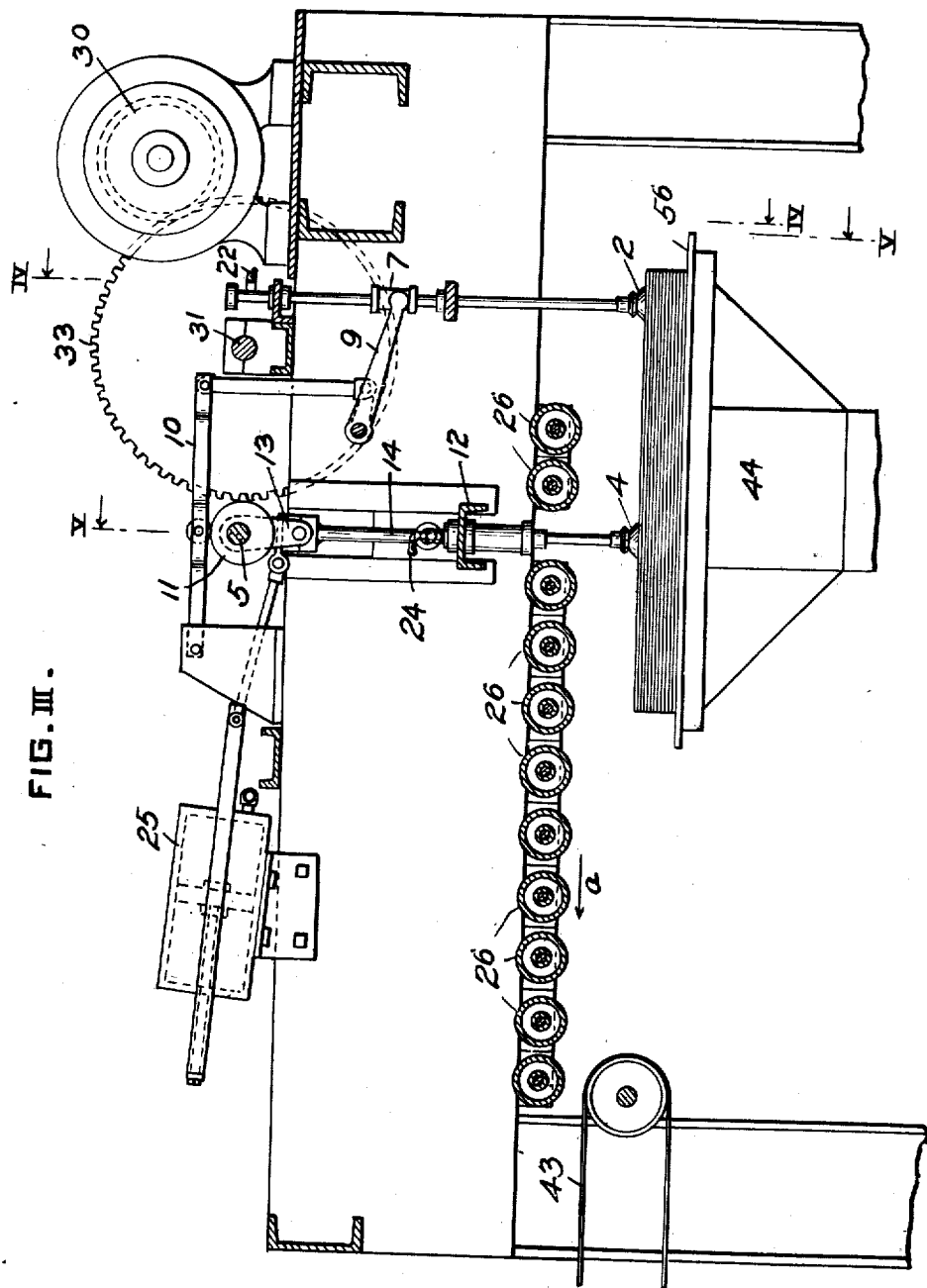


FIG. III.

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1,442,718

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FILED MAR. 4, 1920.

6 SHEETS-SHEET 4

FIG. IV.

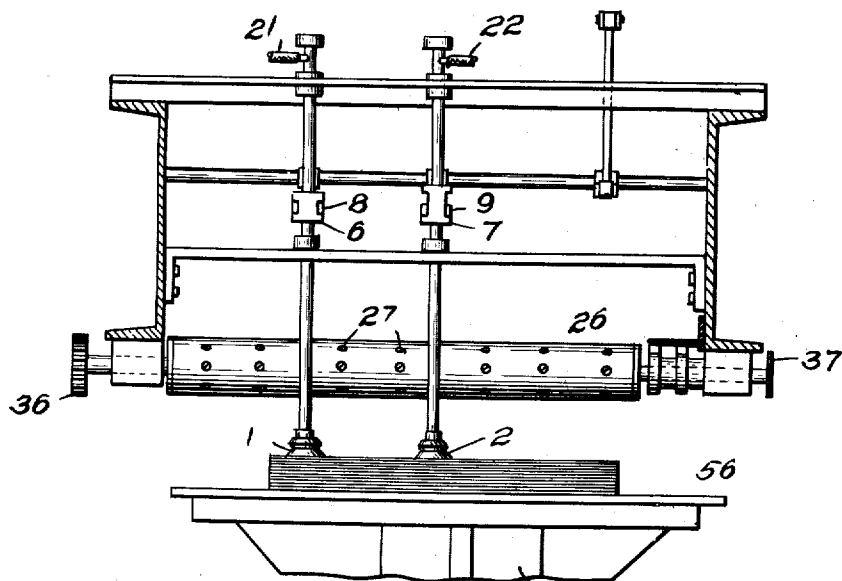
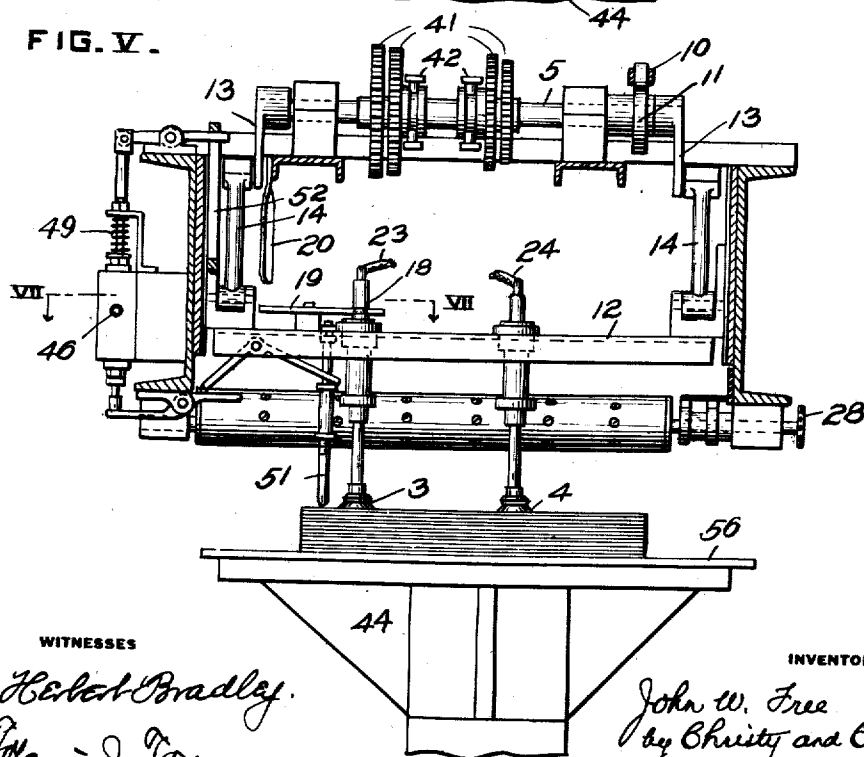


FIG. V.



WITNESSES

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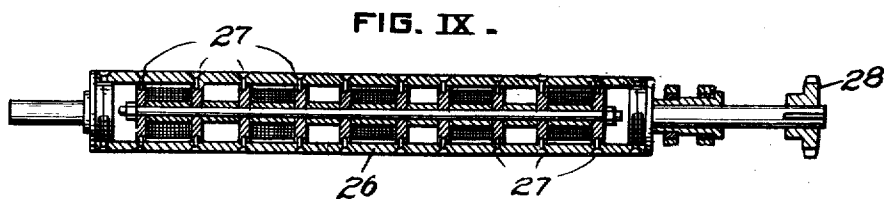
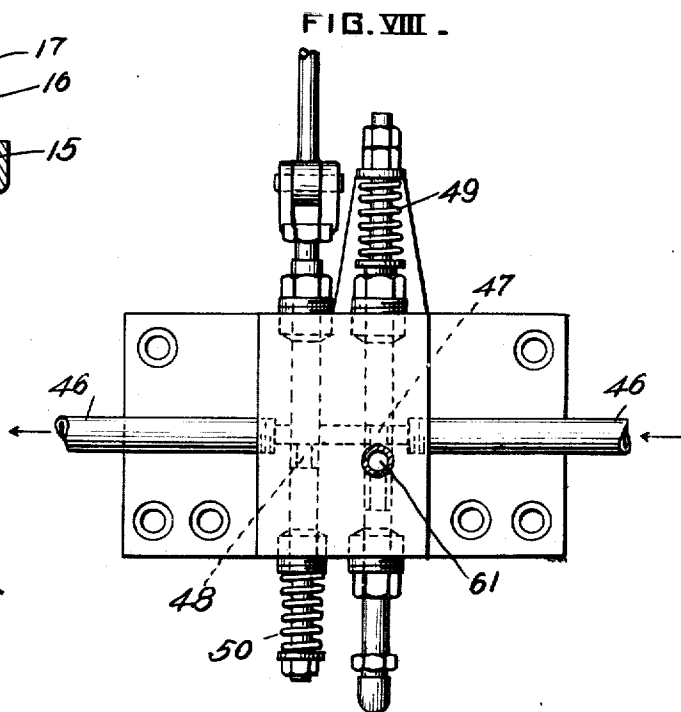
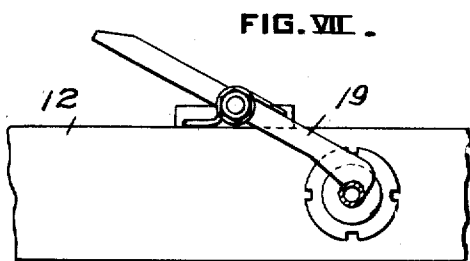
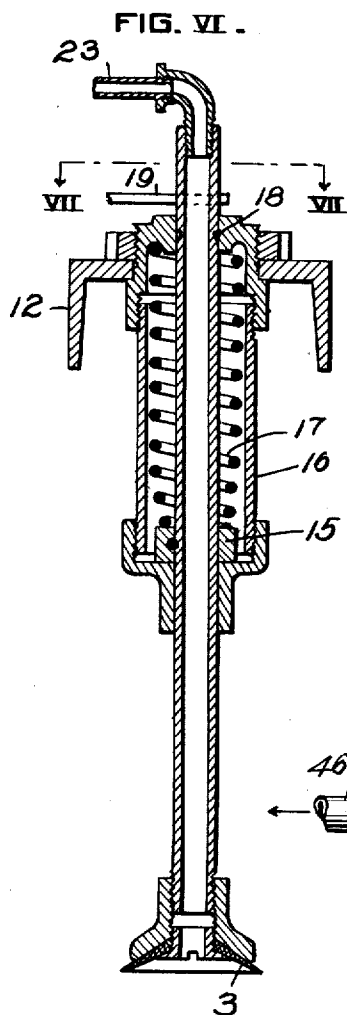
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FILED MAR. 4, 1920

1,442,718

6 SHEETS-SHEET 5



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FILED MAR. 4, 1920.

1,442,718

6 SHEETS-SHEET 6

FIG. X.

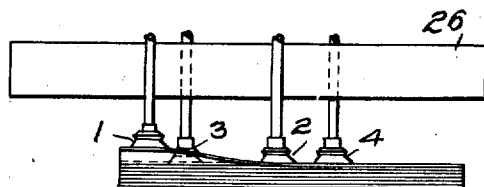


FIG. XI.

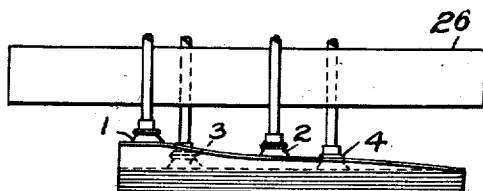


FIG. XII.

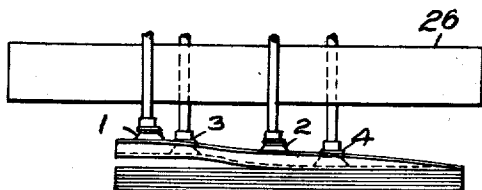


FIG. XIII.

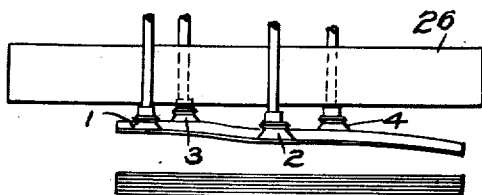
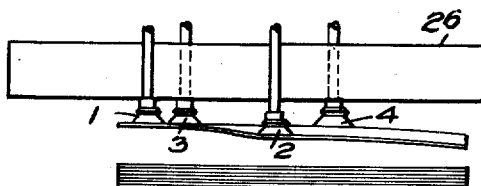


FIG. XIV.



WITNESSES

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UNITED STATES PATENT OFFICE.

JOHN W. FREE, OF WOODLAWN, PENNSYLVANIA, ASSIGNOR TO JONES & LAUGHLIN STEEL COMPANY, OF PITTSBURGH, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

CONVEYER.

Application filed March 4, 1920. Serial No. 363,300.

To all whom it may concern:

Be it known that I, JOHN W. FREE, residing at Woodlawn, in the county of Beaver and State of Pennsylvania, a citizen of the United States, have invented or discovered certain new and useful Improvements in Conveyers, of which improvements the following is a specification.

My invention relates to conveyers. I have applied it to the handling of sheet steel in a rolling mill, and shall show and describe it so applied; but it is of more general applicability, as will on examination be apparent.

In the accompanying drawings, Fig. I is a view in side elevation of my conveyer, adapted to the handling of sheet metal in a rolling mill. Certain associated parts are here shown in vertical section. Fig. II is a plan view of the same apparatus; Fig. III is a view, partly in side elevation, partly in vertical section, on the plane indicated by the line III—III, Fig. II, and showing, to larger scale, part of the apparatus shown in Figs. I and II. In Fig. III certain parts appear in active position, relative to the material under treatment, which in Fig. I appear in inactive position. Fig. IV is a view in vertical section, on the plane indicated by the line IV—IV, Fig. III; Fig. V is a similar view, on the plane indicated by the line V—V, Fig. III. Fig. VI is a view to still larger scale of one of the suction members, seen in vertical central section; Fig. VII is a view in transverse section, on the plane indicated at VII—VII, Figs. V and VI, and to half scale, as compared with Fig. VI, showing in plan the trip which controls this suction member. Fig. VIII is a view in side elevation of a certain connection being shown in section and to larger scale, of a certain water valve, which in Fig. I appears in its assembled position; Fig. IX is a view in longitudinal section through one of the magnetic rollers which, as presently will appear, enter into the organization. The scale is greater than that of Figs. IV and V. Figs. X—XIV inclusive are diagrammatic views, illustrating the relative action of the several suction members. These views are all taken from the

same viewpoint (beyond the right-hand end of the machine as shown in Figs. II and III), and show the assembly of suction members in front elevation.

The machine here shown is designed to pick up by suction the top sheet of a pile of sheets of steel and, raising it, to bring it within the effective field of a succession of magnetized rollers arranged in parallelism. These rollers, having drawn the sheet to contact with their nether surfaces, and being themselves in uniform rotation (the suction members being now out of the way), impel the sheet to the desired point of delivery. For example, sheets of steel in the course of fabrication, delivered from the hot mill, are pickled and annealed, and are then conveniently gathered in piles; in these piles they are conveyed to the cold-rolling mill; and at the cold-rolling mill they are picked up one by one and fed by hand to the mill pass. The pile rests ordinarily on a suitable platform car on which it is conveyed, and the feeding operation involves raising the sheets one by one and then projecting them horizontally to the mill pass. My machine is designed to do this feeding mechanically, and with certainty and precision.

I shall describe, first, suction means of raising sheets of steel one by one from a pile; I shall then describe, in its correlation with the suction raising means, magnetic means for impelling the elevated sheet in transverse direction; finally, I shall describe certain accessory instrumentalities, not essential to the invention in its general applicability, but advantageous in sheet-mill service—accessories which the user of my invention may employ at his discretion—nevertheless, accessories in which too specific invention is found.

The suction raising means include a member adapted to engage the upper surface of the top sheet of a pile and to adhere thereto by suction, and instrumentalities for raising the suction member and with it the sheet to which it adheres. A number of suction members will preferably be employed together; and, as has already been intimated, certain correlations in operation are adopted

to effect particular ends. The particular number is not primarily important; in the machine of the drawings, four are used; the number might be greater or less. Four, however, meet satisfactorily the conditions of service. One who is familiar with sheet mills will gather at a glance from Figs. III, IV, and V all that need be indicated, as to absolute and relative dimensions. These four suction members alternately descend upon and make adhesion upon the top sheet of a pile, and then, rising, lift the top sheet from the pile. The four suction members are indicated in the drawings 1, 2, 3, 4.

These four members are caused to rise and fall by the rotation of a shaft 5; the connections, by means of which a certain order sequence in rise and fall is achieved will here be noted in passing. Members 1 and 2 consist of lengths of pipe vertically carried in suitable supports, terminating below in suction cups with rims of soft and preferably elastic material, such as rubber. These have play in their bearings, and when unrestrained descend by gravity to the limit of permissible movement. These two members are engaged, through collars 6, 7, by lever arms 8, 9, which lever arms, pivoted conveniently on a common shaft, are swung, in unison with another lever arm 10, and the lever arm 10 is swung by the turning of a cam 11 secured to shaft 5. As cam 11 turns, the suction members 1 and 2 are alternately raised by mechanically applied force, and allowed to descend by gravity. By referring to Fig. IV, it will be observed of the collars 6 and 7 that the latter permits within fixed limits a freedom of play between lever arm and collar which is not permitted in the case of the former. The consequence of this is that the lifting strain comes first upon suction member 1, and then after member 1 has already begun to rise it comes upon member 2.

Suction members 3 and 4 are carried in a common vertically movable cross-head 12. This cross-head is positively driven both in ascent and descent, by means of crank arms 13 secured to shaft 5 and connected to the cross-head through links 14. It is to be noted that, accordingly, suction members 3, 4, raised positively like members 1 and 2, are not allowed to descend freely by gravity, but, unlike members 1 and 2, are driven downward as well as upward by mechanically applied force.

The connection of suction member to cross-head is illustrated in Fig. VI. This is a section through suction member 3, specifically; but the construction of the two members and the manner of connection to the cross-head is, in the main, identical. The features peculiar to member 3 will be duly noted. Both suction members are alike (and, thus far, like the suction members 1

and 2) in that each consists of a vertically disposed length of pipe, terminating below in a suction cup. Each suction member 3 and 4 has, rigidly secured to it a block 15, and block 15 is carried by cross head 12, by a connection which is yielding in one direction and rigid in the other. To this end, block 15 is disposed within a cylinder 16, carried in cross-head 12, and normally held to the lower end thereof by the tension of a spring 17. Thus it will be seen that the suction member is carried by the cross-head as that member moves up and down; and, furthermore, while the lifting strain is unyielding, the presence of the spring allows the cross head 12 to descend further, after the suction member itself has come to rest, in engagement with a pile of sheets, and in such further descent to compress spring 17. It will be remarked that, by virtue of the lost motion in the connections between shaft 5 and suction member 2, and by virtue of the spring-backed play of suction members 3 and 4 in cross-head 12, not only will the particular ends presently to be described be effected, but the suction apparatus as a whole will adapt itself to minor irregularities of the surface presented for their conjoint action—and this is important, for a pile of sheets may present an upper surface which is concave or convex or substantially level, or be otherwise variable in contour.

Suction member 3 is further characterized (and herein it differs from member 4) in having a latch which in the operation of the machine automatically opens and closes, to control still more minutely the movement of member 3. In the member 3 itself is a notch 18, and, pivoted in cross-head 12, is a spring-backed finger 19. When in the descent of cross-head 12, suction member 3 having already made contact with the pile of sheets, and spring 17 being under increasing tension, notch 18 comes into alignment with finger 19, the finger springs into the notch, and so locks cross-head and suction member together. This occurs when the descending cross-head reaches the limit of its downward traverse. Thereafter, at a predetermined point in the ascent, the free end of the finger 19, making engagement with a suitably shaped abutment 20, the finger is swung, the engagement in notch 18 broken, and the tension of spring 17 is exerted to give a sudden limited downward thrust to the otherwise rising suction member. The purpose and effect of this will presently be explained. It will, however, be noted that, in consequence of the mounting now described of suction members 3 and 4 upon the cross-head which carries them, the members come successively in action, and lifting is effected, as cross-head 12 rises, first through member 3 and, after an in-

terval, through member 4 also. It should further be remarked that cam 11 and crank arms 13 are so related in position upon shaft 5, that suction member 2 begins to rise slightly in advance of member 3. The order, then, in which the members begin to lift is the numerical order, 1, 2, 3, 4. Cam and crank arm are further so shaped and relatively arranged that members 1 and 2, approaching the limit of their rise, are overtaken by members 3 and 4, and so the lifted sheet is presented in substantially horizontal position to the magnetic members presently to be described.

From the several suction members 1, 2, 3, and 4 flexible pneumatic connections, 21, 22, 23, and 24 lead to a pneumatic cylinder 25, in which is a piston whose stem is linked conveniently to one of the crank arms 13. The piston is so arranged that by the turning of shaft 5 suction is exerted through the connections enumerated and the connected suction members, at the time when lifting force is exerted on the suction members.

With particular attention to Fig. III, it will be observed that a half turn of shaft 5 in clockwise direction will carry the suction members from their lowermost position (which is the position shown in Fig. III) to their highest position, and that during the first quarter of this half turn the piston within cylinder 25 will be impelled in one direction (to the left), and during the second quarter it will be impelled in opposite direction. During the first quarter, suction is applied; during the second, suction is relieved, and instead air is blown through the suction members. The description of the remainder of the apparatus is at this point so far anticipated, as to note that, when shaft 5 has turned through the first quarter of its revolution and the suction members have accordingly risen half way, the sheet which has been raised has been brought to position within the effective range of the magnetic conveyer. The further rise of the suction members carries them out of the way, allowing the sheet to be carried away transversely before the suction members descend again. Incidentally, the reversal of pneumatic pressure and the blowing through the suction pipes, which follows immediately when the limit of the suction movement of the piston in cylinder 25 is reached, is advantageous, to ensure the release of the sheet from the suction members—their essential work being then done and the sheet being now at the disposal of the magnetic conveying means.

From a theoretical consideration it might seem that blowing would not ensue immediately upon the reversal in a direction of the piston of cylinder 25. Practically however this is the case. Without going into the matter of possible leakage at the

rims of the suction cups; it will suffice to say that the cups themselves are such in dimensions and are made of such material, and are so related in size to the size of the cylinder 25, and the cylinder 25 is itself so positioned and the whole so related to the weight of the sheet to be raised, that in consequence and effect immediately, or substantially so, on the reversal of the piston in its reciprocation in cylinder 25, suction will be broken and the blowing action described will be set up.

It would manifestly be a simple matter to mount and operate this plurality of suckers in such manner that they should descend, exert suction, rise, and release from suction, all in unison, and it remains to indicate why the elaborate succession of action which has been minutely described, is resorted to.

Such articles as sheet metal, because of thinness, weight when piled, initially high temperature, and subsequent cooling, tend to adhere together; and when the top sheet is raised, it tends to carry with it underlying adhering sheets. I have discovered that by raising the sheet at one corner first, I relieve whatever suction might otherwise arise tending to hold the lower sheet fast to the upper, and further that by giving to the sheet when lifted clear of pile a sudden undulation I break it free, in case the next lower sheet remains still fast to it, whatever be the reason.

Referring again, on this point, to the drawings, it will be remembered, first, that the suction members begin to lift successively, in the order 1, 2, 3, 4; second, it will be noted (cf. Figs. III and IV) that member 1 is at the very corner of the pile—two inches, in fact, from each edge; third, that the other three members are so spaced and disposed as to engage small sheets as well as large, and, when engaging large sheets, to sustain them with a minimum amount of sagging. The superiority of the arrangement shown to one in which the four suction members should be placed over the four corners of a large sheet will be apparent to one who considers this matter with the drawings before him—the drawings being intended to show operation on large sheets. Members 2 and 4 are so placed that they come to bearing near to the mid line of the sheet, member 4 being somewhat beyond the mid line and nearer the opposite edge, while members 3 and 4 are situated rearward of members 1 and 2 approximately two-thirds the length of the sheet, and member 3, it will be observed (cf. Fig. II) is farther removed from the edge of the sheet than is member 1. The location of member 1 being, for purposes already defined, fixed, the locations of the other members are such that the drag of the weight of the sheet, tending to break the suction

hold, is as evenly balanced as may be around the rim of each suction cup.

Figs. IV and V show the suction members all down. From these figures attention is directed to the diagrammatic figures, X-XIV. Fig. X shows the first stage in lifting; suction member 1 alone has risen; the sheet still rests on the pile over the greater part of its extent, but one corner has been raised, and suction conditions are in the way of being relieved. While member 1 is thus rising through its first stage, the lost motion in the connection to member 2 is being taken up, while the previously compressed springs 17 are expanding and so allowing members 3 and 4 to continue at their lowest positions. Fig. XI shows the second stage; here member 1 continues to rise, and member 2 follows at an interval; members 3 and 4 have not yet begun to rise, for the expansion of springs 17 is still in progress. At this stage there is further relief of suction conditions between the top sheet and the sheet immediately beneath. Fig. XII shows members 1, 2, and 3 at successive points of rise, member 4 remaining still unmoved. The rise of member 3 is due to the fact that finger 19 has engaged notch 18 and further expansion of spring 17 is arrested. Fig. XIII shows all four members lifting, and shows further that members 3 and 4 have overtaken members 1 and 2 and brought the sheet to a substantially horizontal position. When the members are in this position the spring 17 for member 4 has already fully expanded, and block 15 has already been brought to the end of cylinder 16, but the spring for member 3 is still locked with block 15 short of the end of its traverse. Fig. XIV indicates that, while the other members have risen, member 3 has, relatively to them, descended. This has come about by virtue of the fact that finger 19 has by engagement with abutment 20 been swung, and spring 17 has carried the now unrestrained member downward until its block 15 has come to stop against the head of cylinder 16. The effect of this has been to give a sudden warp or wave to the sheet, to the end that, in case the next lower sheet has still continued to adhere (as sometimes is the case) in a union not broken by the manner of lifting, it will now more certainly be released and will fall back upon the pile.

To give specific figures—which are given by way of example merely—from the machine which I have built and in which I have demonstrated the practicability of my invention, the sheets upon which I operate are 20 by 28 inches of 20 gauge. Suction member 1 is arranged, as I have said, two inches from each edge; member 2 stands at the same distance from the forward edge of the sheet and 8 inches from member 1; member 3 is 18 inches rearward from member 1 and 5 inches from the side edge of the sheet; and

member 4 is aligned with member 3 and is spaced 9 inches from it; accordingly it stands 4 inches beyond a longitudinal line passing through member 2. The lift of the sheet, from the top of the pile to the nether faces of the rollers of the magnetic conveyer is $4\frac{1}{2}$ inches. Suction member 1 rises $1\frac{1}{4}$ inches before member 2 begins to rise; member 2 rises $\frac{3}{4}$ of an inch before member 3 begins to rise; member 3 rises $\frac{1}{2}$ inch before member 4 begins to rise. When finger 19 is swung and member 3 is impelled downward by the tension of spring 17, the range of this downward drive is $\frac{1}{2}$ inch. This occurs when the rising plate is still $1\frac{1}{2}$ inches from the faces of the rollers of the magnetic conveyer. The piston within cylinder 25 reaches the limit of its suction stroke and begins to move in opposite direction, when the sheet has been brought to within $\frac{1}{4}$ of an inch from the rollers of the magnetic conveyer. At that point the sheet is within the secure hold of the conveyer, the ensuing blowing of air through the suction members insures separation of the suction members from the sheet, while the farther rise of the suction members first allows the sheet to come into contact with the rollers of the magnetic conveyer, and then the further rise of the suction members allows the sheet to move freely away in response to the traction exerted by the rollers of the magnetic conveyer.

The magnetic conveyer, which cooperates with the suction conveyer now described, consists of a succession of rollers 26 arranged in parallelism, energized to attract and hold against their surfaces, in a position tangent to all, a sheet of steel. These rollers all rotate in unison, in a common direction (clockwise, as shown in Figs. I and III), and as they rotate they carry forward, in the direction indicated by the arrow *a* a sheet of steel adhering to their nether faces.

The particular formation of these magnetic rollers does not concern me; such rollers are on the market, and the illustration afforded in Fig. IX is given merely to make the showing complete. Within a hollow brass roller is set in axial alignment a succession of electromagnets, alternate in polarity—that is to say, the negative pole of one adjacent the positive pole of its neighbor. These magnets are energized in suitable manner. It appears that by using screws of steel rather than of brass penetrating the shell of roller 26 and securing the electromagnets within, the magnetic effect is rendered more pronounced. In the showing made in Fig. IX, the securing screws alluded to are indicated at 27.

Turning now to Fig. III particularly, it is to be noted that the rollers 26 which constitute the magnetic conveyer constitute a series which overlies in part at least the pile of sheets; that some of the rollers of the se-

ries are conveniently arranged between the suction members; and that the arrangement is such as to carry the sheets away in a direction transverse to the direction in which the sheets are carried from the pile and brought into contact with these rollers 26. Ordinarily, the lift of the suction conveyer is vertical, and the traverse of the sheets in the magnetic conveyer is horizontal. Accordingly, the drawings show the rollers 26 horizontally disposed, and the series extending in horizontal plane. It is manifest that in such particulars the showing is exemplary, and in every case the arrangement will be adapted to the existing conditions.

The rollers 26 may be rotated together in uniform direction and at uniform speed by providing each with a terminal sprocket wheel 28 (cf. Fig. IX), and driving all through a common sprocket chain 29 (cf. Fig. II).

The two conveyers described—the suction conveyer and the magnetic conveyer—may conveniently be driven by a single motor. Explanation has been made, that the suction conveyer is driven by rotation of shaft 5, and that the magnetic conveyer is driven by the sprocket chain 29. Turning now to Figs. I, II, and III, a motor 30 is shown, conveniently mounted on a framework which carries the parts already described. A shaft 31 is rotated by motor 30, through pinions 32 and 33. Shaft 31 carries a pinion 34 and from this pinion rotation is imparted through pinions 35 and 36 to a sprocket wheel 37 which drives sprocket chain 29 (cf. Fig. IV), and, through pinion 38 to shaft 39. Shaft 39 and shaft 5 are connected through one or another pair of two sets of pinions 40 and 41. The set of pinions 41 is splined to shaft 5 and movable longitudinally thereon through the clutch mechanism shown in plan in Fig. II and generally designated by the reference numeral 42, and the pairs of pinions are of varying relative dimensions, to the end that the relative speed of the two conveyers may be varied. In case the sheets handled are of small dimension, the speed of the suction conveyer relatively to that of the magnetic conveyer may be greater than when the sheets are large.

The drawings show a belt conveyer 43, upon which the sheets fall one by one by gravity as they are carried by the series of magnetic rollers 26 in the direction indicated by the arrow *a*. This conveyer serves in an exemplary way merely; it will be understood that delivery might be made from the magnetic conveyer directly to the roll pass of a cold-rolling mill, or to any other preferred place of delivery.

It remains only to explain the apparatus which I preferably employ for bringing a pile of sheets to position beneath the suction

conveyer and for maintaining the top of the pile at a substantially constant level, while the sheets are raised one by one from it.

A hydraulic ram 44 working in a cylinder 45 is provided, for sustaining the pile of sheets while the conveyer apparatus is engaged in picking them up and carrying them one by one away. The ram is raised by a water supply communicated under sufficient head through a pipe 46. In the line of communication through this pipe two valves 47 and 48 are set (cf. Fig. VIII), one of which (47) is held normally open by the tension of a spring 49, the other (48) is held normally closed, by spring 50. In beginning operations, crosshead 12 is caused to descend, and by connections presently to be explained, valve 48 is thereby opened. The water conduit 46 is then brought under the head of the supply automatically or (as by opening a valve 60) manually and the ram rises under the head applied, until the top of the pile comes to the desired level. The pile there engages the vertically sliding finger 51 (Fig. V) and finger 51 moving operates a lever mechanism through which valve 47 is closed against spring tension, and the rising of the ram ceases. Crosshead 12 carries a link 52 and this link which when the crosshead is down engages a lever mechanism and opens valve 48 against spring tension, releases as the cross head raises the valve and allows it to close under spring tension. Accordingly, as will now be apparent, in the normal operation of the machine, each full downward stroke of the crosshead 12 (which, it will be remembered, carries suction members 3 and 4) will, through the link 52, open valve 48 against the tension of spring 50. Any fall in level of the top of the pile from the standard maintained by finger 51 will effect opening of valve 47, and, valve 47 being in any degree open, the periodic opening of valve 48 will establish water connection from source through pipe 46 to cylinder 45 and effect rising of the ram. Thus gradually the ram rises, to compensate for diminution in depth of the pile of sheets upon it, the top of the pile being maintained always at a constant level.

The accuracy of the operation of the parts just described might otherwise fail, in case the valves 47 and 48 or either of them became leaky, were it not for a drain connection 61 which comes to register with the water supply conduit 46 in case of extreme rise of valve 47 against the tension of spring 49, and relieves the ram of the pressure of the head of water. This emergency rise would occur when the pile of sheets, improperly controlled should rise to a higher level than intended. The drain 61 is then in the nature of an emergency valve checking the rise of the pile and permitting operation to continue, even though either of

the valves 47 and 48 should not be properly working.

A valve 62 will be provided, and will be under proper control, to the end that the ram cylinder may at will be opened to a drain, and so the ram after its use, and after the conveyer has done its work, may recede.

A car 55 may be provided to bring a pile of sheets from an adjacent point of delivery to position where the ascending ram may pick up the load. Such a car will conveniently be provided with a skeleton frame and with a plurality of removable plates to constitute the platform 56. This car has a range of to and fro movement upon rails above ram 44; its range however is limited; the space between the axles of its sustaining wheels at opposite ends is greater than its range of movement, and accordingly neither axle is required to pass across the path of the ram in its rise and fall. The car is moved on its tracks to one end of its range; a pile of sheets built up on a plate 56 is then placed upon it at the end then remote from the ram. The car is then shifted, and the pile brought to position above the then retracted ram. The ram then rises, and in so doing lifts plate 56 with the pile of sheets upon it. The car may then be moved back again to its loading position. Meanwhile the ram in rising brings the pile of sheets to position, as already explained.

Operation requires no prolonged rehearsal, for the operation of the several parts has in the course of the foregoing description been indicated. To begin with, the ram if not already retracted is caused to descend by opening the cylinder 45 through valve 62 to the drain pipe. Valve 62 is then closed. A load of sheets piled on a plate 56 on car 55 is, by movement of the car brought to position above ram 44. The crosshead 12 then descends and valve 48 opens. In consequence ram 44 rises and, engaging plate 56, carries it and the pile of sheets upon it upward until the top of the pile, shifting finger 51, effects closure of valve 47. Thereafter, so long as the removal of sheets from the pile continues, the position of the ram will automatically adjust itself, so that the top of the pile will remain at a constant level.

While this continues, the turning of shaft 5 from motor 30 will cause the suction members to descend and ascend periodically, and with each ascent the suction members will raise a single sheet, free it certainly from its next underlying fellow, and bring it into the effective range of the magnetic conveyer. Thereupon, the suction members will recede, and at the same time the magnetic rollers will carry the sheet in transverse path to the desired point of delivery, leaving the way free for the next descent of the suction members.

As has already been said, the speed of operation of the suction conveyer may be increased or decreased at will, relatively to the speed of the magnetic conveyer, and herein is accommodation, to gain most effective operation at all times, though the sheets handled vary in size.

When the pile of sheets has been all delivered from the ram (or at any other time), a shifting of valve 62 will cause the ram to descend, and in its descent to leave the plate 56 resting again on the skeleton frame of car 55, suitably stationed beneath.

If two points of sheet supply be established at opposite ends of the range of car movement, the car will remain stationary while the ram is rising and descending again, and while so standing the car may receive on its protruding end (and this will be alternately, first one end and then the other) a new pile of sheets.

In the ensuing claims I define the essential features of my invention; beyond these essential features, the showing of this specification is merely exemplary. Variation in non-essentials is permissible, and my invention will still be employed if these essential features be present.

I claim as my invention:

1. A conveyer for sheet material including a plurality of suction members movable rectilinearly in lines transverse to the plane of the sheet material to be conveyed, and in their conjoint operation coming successively to such rectilinear movement, substantially as described.

2. A conveyer for sheet material including a plurality of suction members movable from a lower to a higher level and means for imparting to one of said members a downward thrust while the said members are in course of operation and sustaining a sheet of material, substantially as described.

3. A conveyer for sheet material including a plurality of suction members movable from a lower to a higher level and in their conjoint operation coming successively to the rise, and means for imparting to one of said members a downward thrust while the said members are in course of operation and sustaining a sheet of material, substantially as described.

4. A conveyer for sheet material including a rotary shaft, a plurality of suction members, separate connection from said shaft to each of said suction members, one such connection being elastic, whereby the turning of the shaft communicated through one of said connections effecting a rise of one of said suction members effects at the same time compression in the elastic connection without movement of the suction member with which such elastic connection is established, substantially as described.

5. A conveyer for magnetic material in-

cluding in its structure a suction device and a magnetic device, said suction device being adapted to engage an article from above and to raise it from a lower to a higher level, said magnetic device being adapted to receive and to sustain against gravity and to carry away transversely an article of magnetic material carried toward it from beneath by said suction device.

6. A conveyer for magnetic material including in its structure a suction device and a magnetic device, said suction device being adapted to engage an article from above and to raise it from a lower to a higher level, said magnetic device being adapted to receive and to sustain against gravity and to carry away transversely an article of magnetic material carried toward it from beneath by said suction device, said suction device in the range of ascent passing to and beyond the point where the article comes to place relatively to said magnetic device.

7. A conveyer for magnetic material including in its structure a suction device and a magnetic device, said magnetic device including a plurality of horizontally extending magnetic rolls their nether faces disposed in a common horizontal plane, said suction device being vertically movable and being adapted and arranged to engage an article of magnetic material lying at an interval beneath said magnetic device and to raise such article toward said magnetic device, said suction device being movable upward beyond the point at which the elevated article comes to tangency with the rolls of said magnetic device.

8. A conveyer for superposed sheets of magnetic material including in its structure a plurality of suction members movable from a lower to a higher level and coming into movement at successive and predetermined intervals, and a magnetic conveyer into the effective range of which the sheets are individually brought by the rise of said suction members, substantially as described.

9. A conveyer including in its structure a vertically movable cup, means for alternately setting up suction and blowing in said cup, means for raising said cup, the means being correlated and suction exerted within the cup during an earlier and blowing during a later portion of the rise of the cup, substantially as described.

10. A conveyer including in its structure a vertically moving cup, means for alternately setting up suction and blowing in said cup, means for raising said cup, means for receiving at an intermediate point in its rise from said cup material raised by said cup, the means being correlated and suction being exerted in said cup until in the range of its rise the material is brought to the point where the receiving means are located,

and thereafter in the further rise of said cup blowing being established therein substantially as described.

11. A conveyer for magnetic material including in its structure a vertically moving cup, means for alternately setting up in said cup conditions of suction and of blowing, a magnetic conveyer arranged to operate on material raised by said cup while said cup is at an intermediate position in its range of rise, the said means being correlated, and suction conditions maintained in said cup throughout its rise until the material has come within effective range of said magnetic conveyer and thereafter during further rise of said cup blowing conditions being maintained within it, substantially as described.

12. In a conveyer means for elevating one by one a succession of articles, means for carrying the articles away in transverse path as they come successively to the high point of their elevation, means for driving the elevating and the transversely carrying means, and means for varying the relative speed of the said elevating and transversely carrying means, substantially as described.

13. A conveyer for raising from a pile one by one a succession of flexible sheets, a plurality of suction members, one of said suction members being arranged to engage the successive sheets at a point adjacent one corner and another of said suction members arranged to engage the said sheet at a point so related to the first that the sag on opposite sides thereof shall be equalized, substantially as described.

14. In a conveyer the combination of a carrier movable first toward material to be conveyed and then in sequence in opposite direction, two suction members borne by said carrier and each movable with respect to said carrier, spring-backed connection between one of said members and said carrier, whereby the said member may remain at rest engaging the material to be conveyed while the carrier continues to move toward such material, and means for shifting the other of said members in its bearing in said carrier while said carrier is in course of its sequent oppositely directed movement, substantially as described.

15. In a conveyer the combination of two suction members borne in suitable carrier mechanism, and means adapting said members to conjoint action upon material presenting irregularities of surface, such means consisting of yielding connection between each of said members and its carrier, means for locking one of said members to said carrier mechanism while the other continues in yielding connection therewith, and for subsequently releasing the member first identified from such locking, substantially as described.

16. In a conveyer the combination of

three suction members borne in suitable carrier mechanism, yielding connection between the second and the third of said members and the carrier mechanism, whereby, while
5 the first member is lifting the second and the third may continue to exert downward stress upon said material, means for locking the second of said members to said carrier mechanism while the third member continues in
10 yielding connection therewith, and for subsequently releasing said second member from such locking, substantially as described.

17. In a conveyer for superposed sheets of material means for raising the sheets one
15 by one, and means for imparting a warping movement to a sheet while held in suspension, substantially as described.

18. In a conveyer for superposed sheets of material, means for raising the sheets one
20 by one beginning at one corner of the sheet and progressively raising remaining por-

tions and means for imparting a warping movement to the sheet when fully raised, substantially as described.

19. A conveyer for magnetic material in- 25 cluding a magnetic member adapted to receive from beneath a sheet of magnetic material and to carry it away transversely, and a suction cup adapted to engage a sheet of material from above, and to elevate it ver- 30 tically, the said magnetic member and the said cup being so relatively arranged that a sheet borne and elevated by said cup is engaged by said magnetic member before the said cup has reached the limit of its upward 35 traverse.

In testimony whereof I have hereunto set my hand.

JOHN W. FREE.

Witnesses:

BAYARD H. CHRISTY,
FRANCIS J. TOMASSON.

Certificate of Correction.

It is hereby certified that in Letters Patent No. 1,442,718, granted January 16, 1923, upon the application of John W. Free, of Woodlawn, Pennsylvania, for an improvement in "Conveyers," an error appears in the printed specification requiring correction as follows: Page 5, line 97, beginning with the word "releases" strike out all to and including the word "tension", line 98, and insert instead the words *releases the valve as the crosshead rises and allows the valve to close under spring tension*; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 18th day of March, A. D., 1923.

[SEAL.]

KARL FENNING,
Acting Commissioner of Patents.