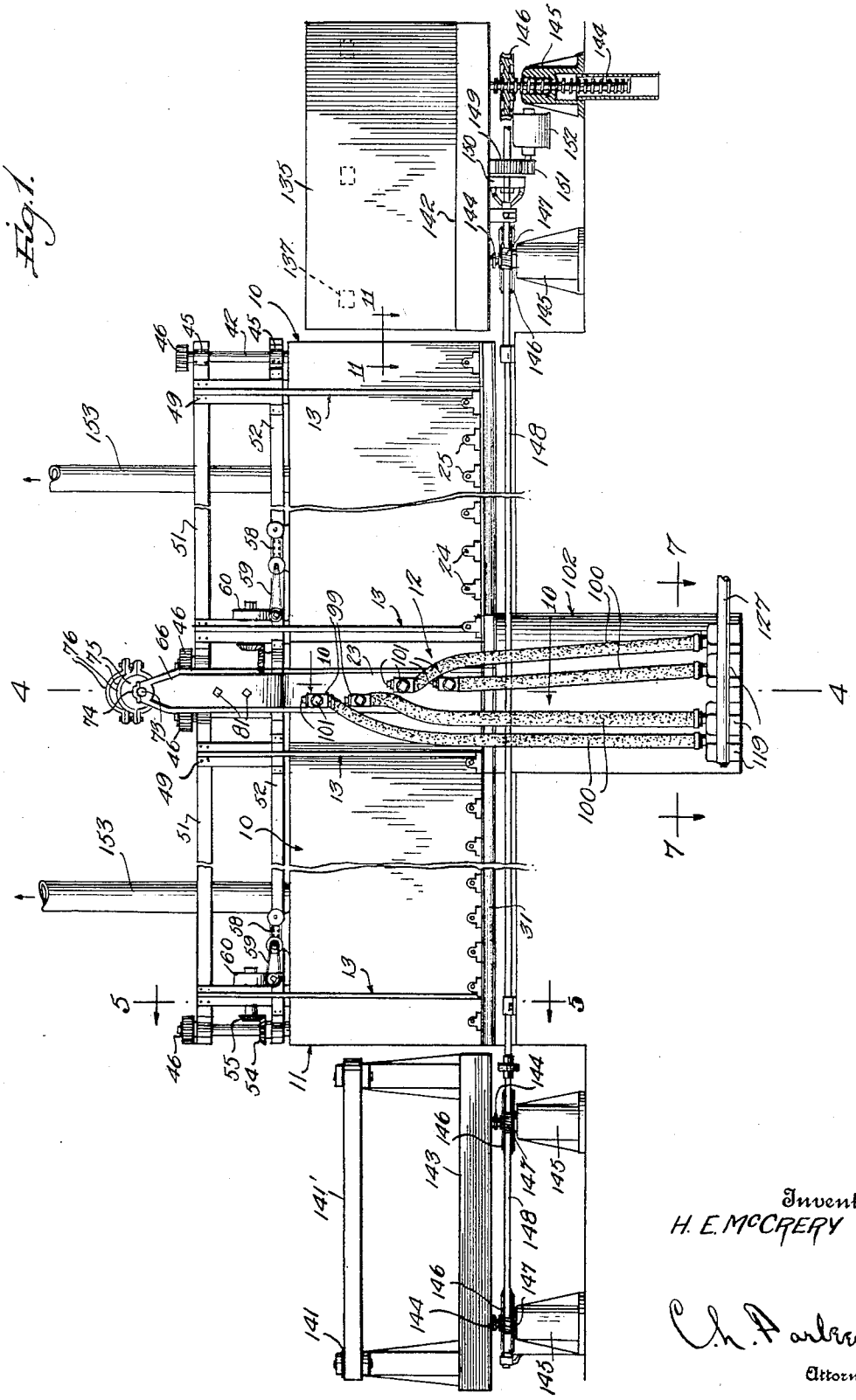
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METHOD AND APPARATUS FOR CLEANING SHEET METAL

Filed Dec. 15, 1927 7 Sheets-Sheet 1

Fig. 1.



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METHOD AND APPARATUS FOR CLEANING SHEET METAL

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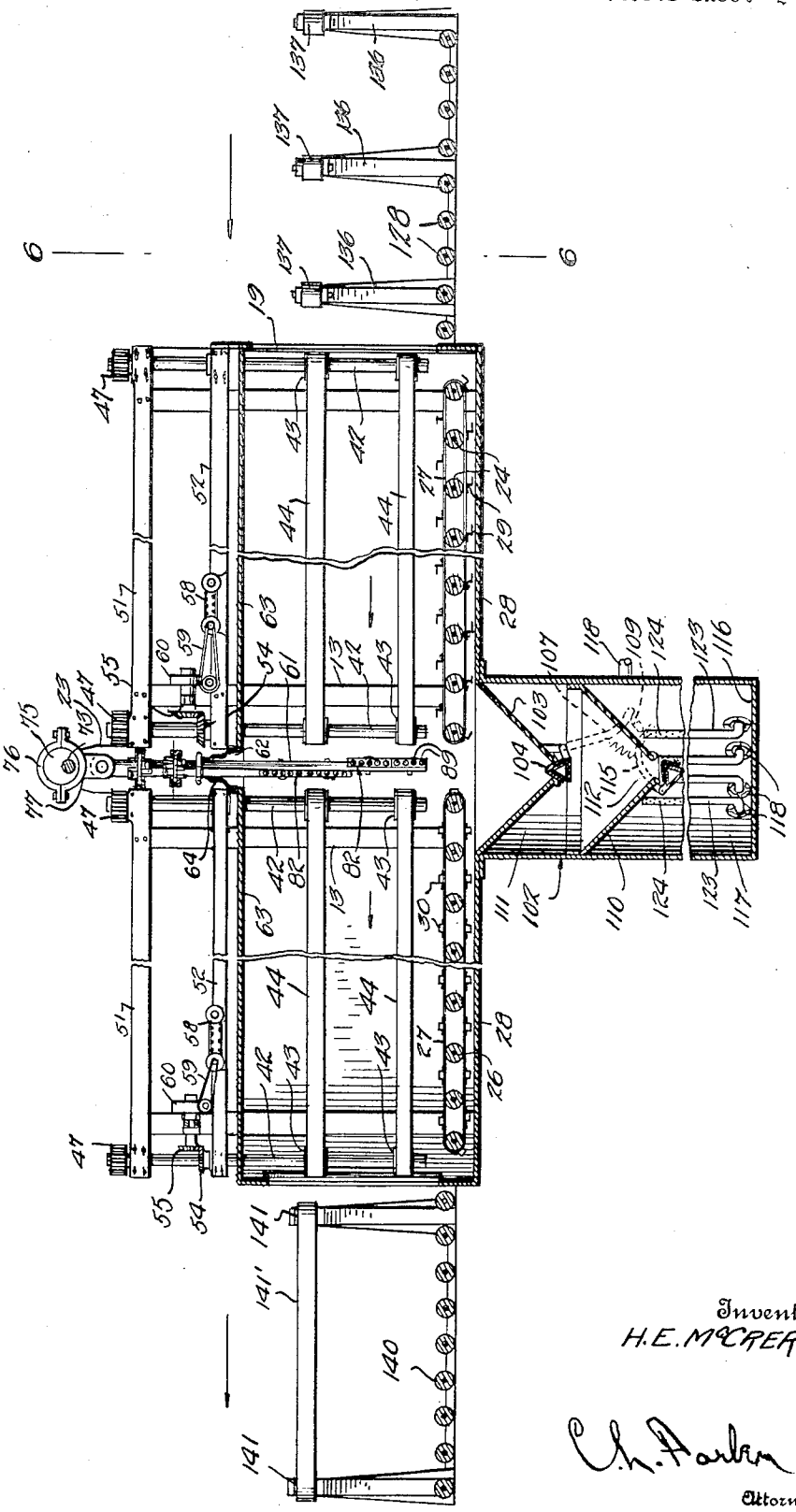


Fig. 2.

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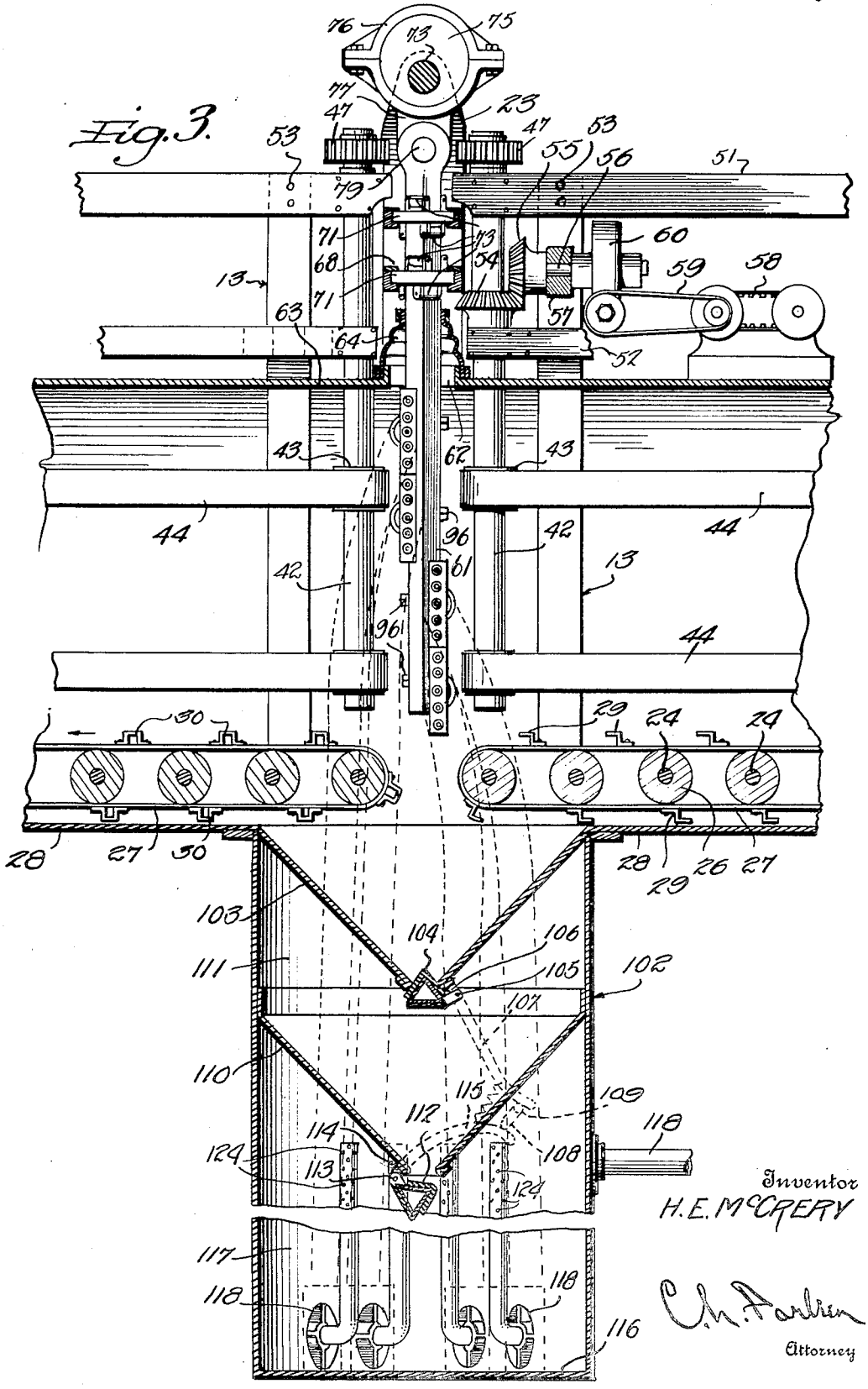
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METHOD AND APPARATUS FOR CLEANING SHEET METAL

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Fig. 3.




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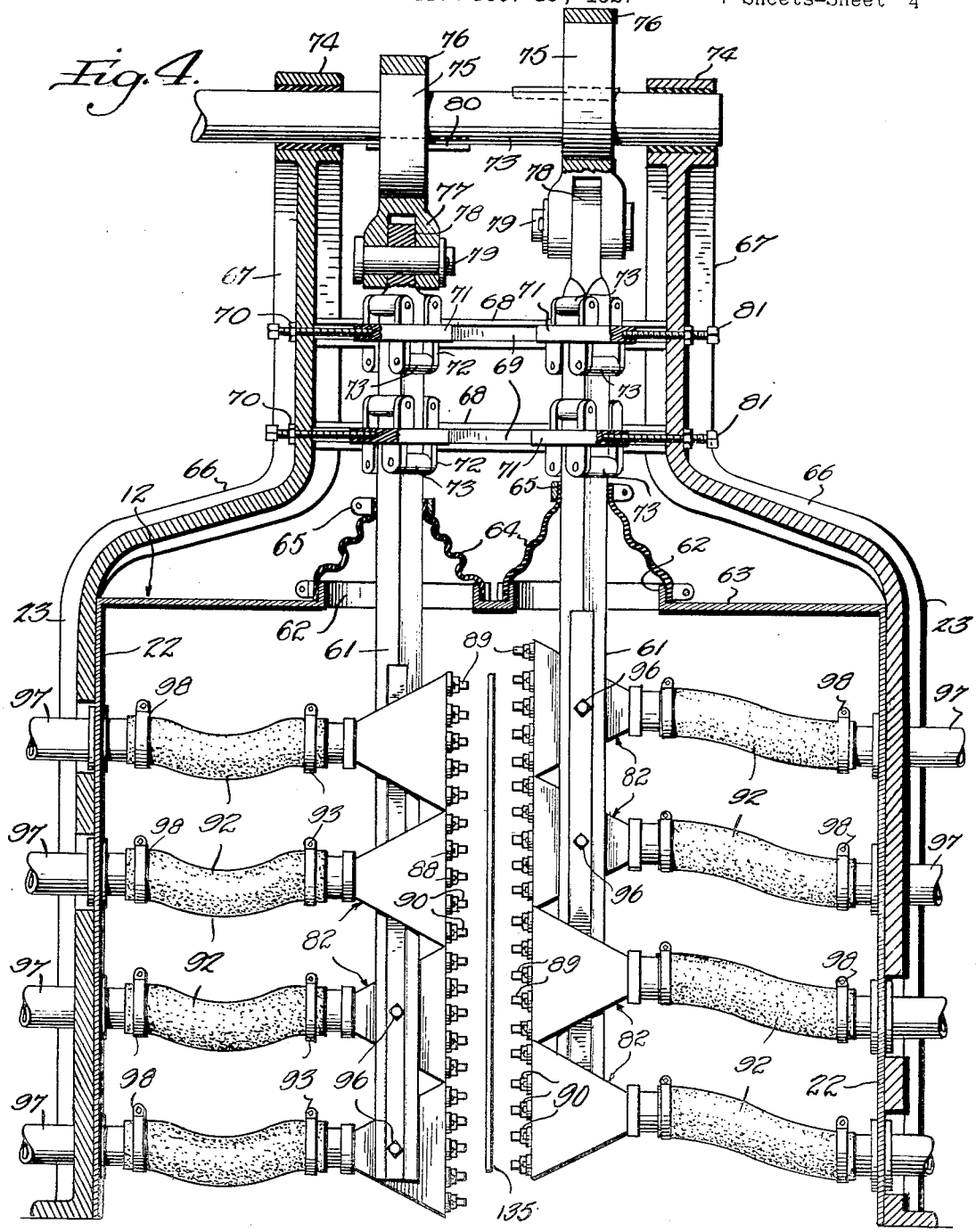
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METHOD AND APPARATUS FOR CLEANING SHEET METAL

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Fig. 4.




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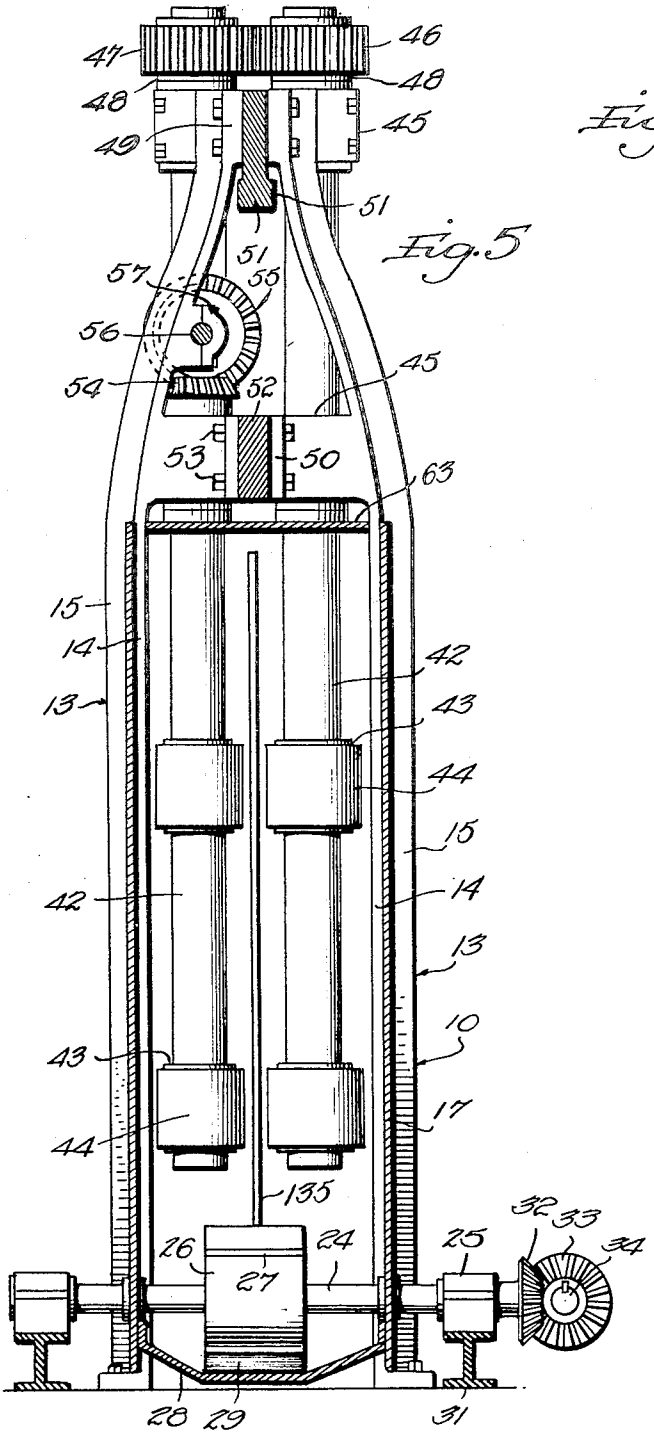
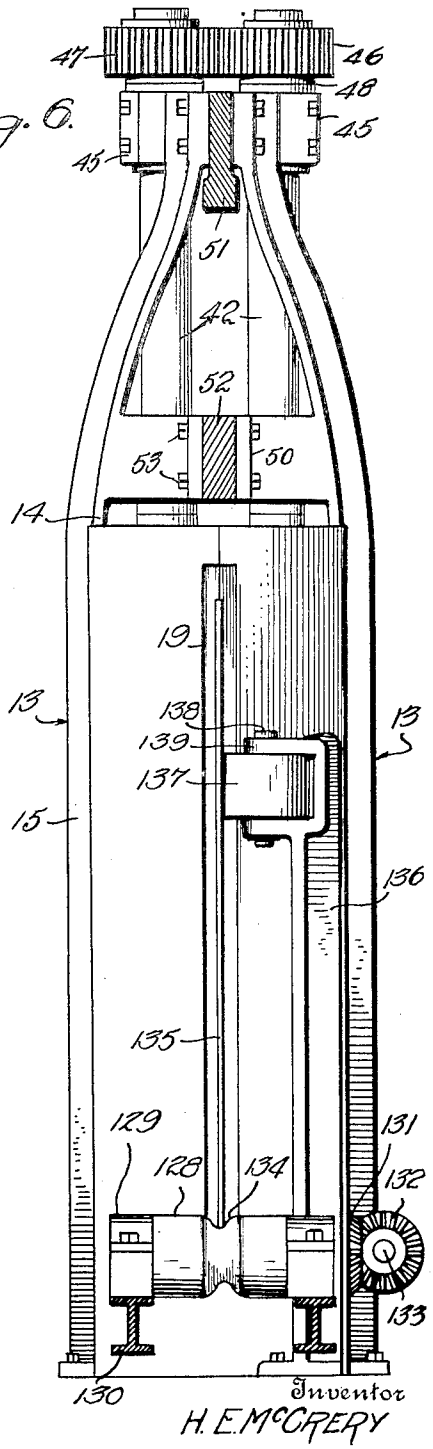



Fig. 5.

Fig. 6.




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Fig. 7.

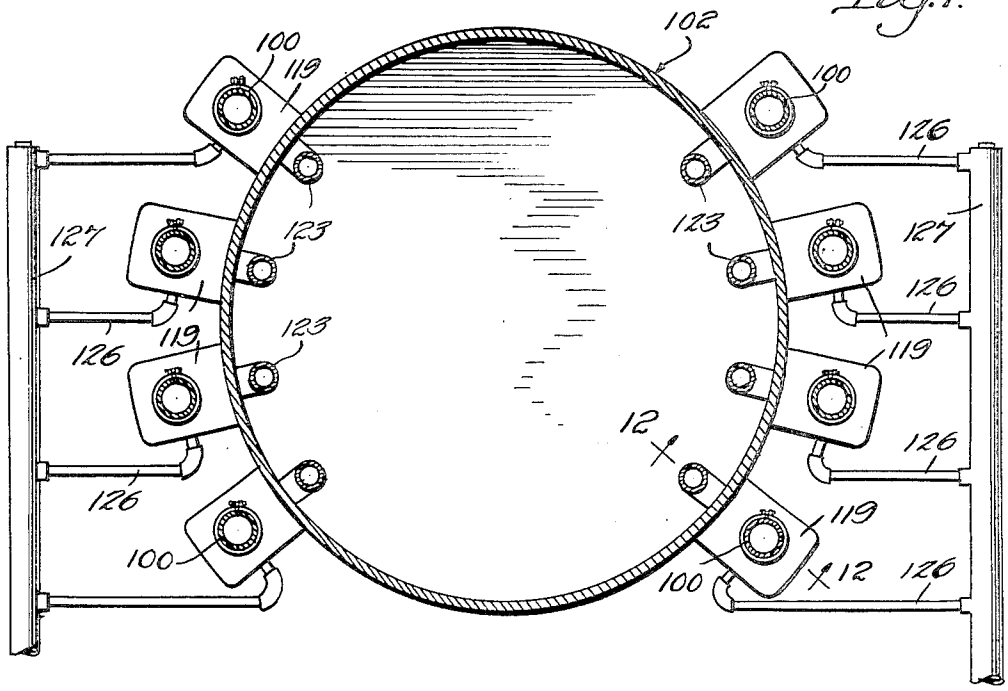
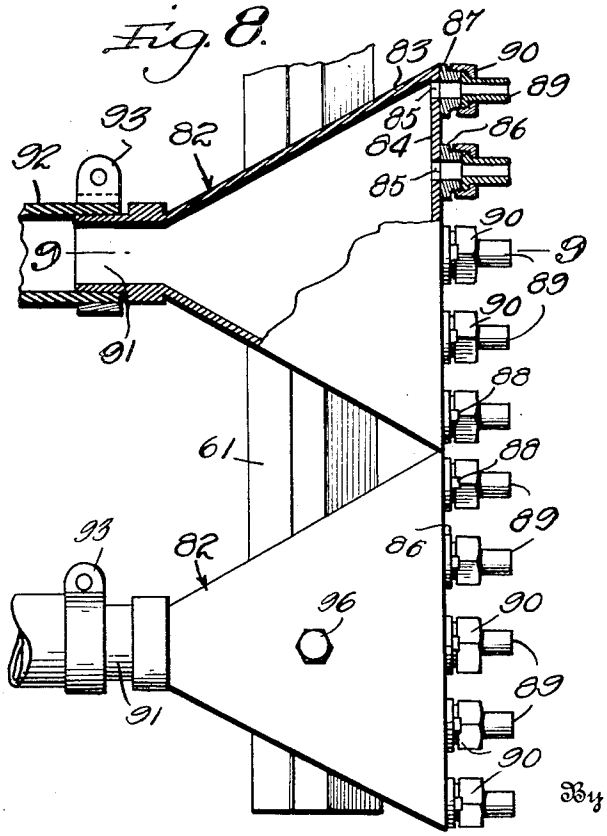



Fig. 8.



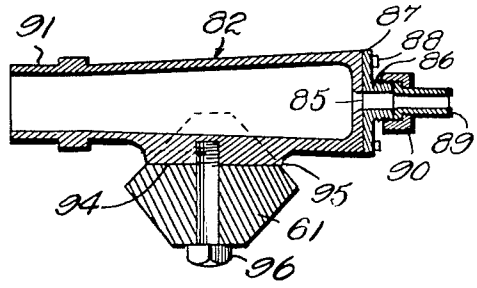




Fig. 9.

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METHOD AND APPARATUS FOR CLEANING SHEET METAL

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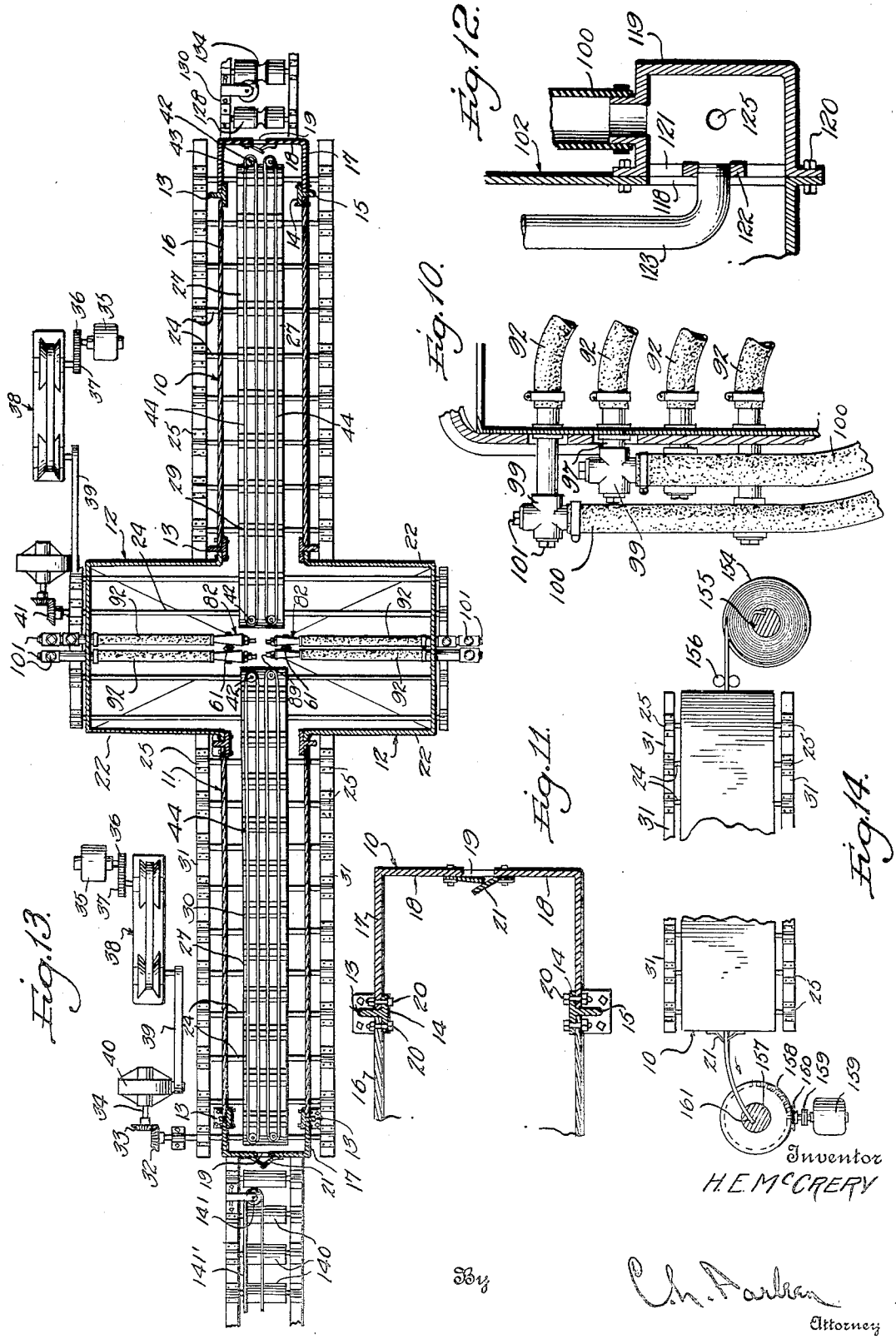


Fig. 13.



Fig. 12.

Fig. 10.



Fig. 11.

Fig. 14.

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# UNITED STATES PATENT OFFICE

HAROLD E. McCRERY, OF APOLLO, PENNSYLVANIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO BLAW-KNOX COMPANY, OF PITTSBURGH, PENNSYLVANIA, A CORPORATION OF NEW JERSEY

## METHOD AND APPARATUS FOR CLEANING SHEET METAL

Application filed December 15, 1927. Serial No. 240,310.

This invention relates to a method and apparatus for cleaning sheet metal.

It is the present practice to clean scale and other foreign matter from sheet metal by subjecting the sheets to the action of a pickling bath, which operation possesses several disadvantages. The pickling action usually requires about six hours and the sheets must be left immersed in the acid bath until the most tightly adhering portions of the sheets are removed and consequently other portions of the sheets become slightly pitted by the action of the acid. After the pickling action has been completed, it is necessary thoroughly to wash the sheets to remove all traces of acid therefrom to prevent corrosion of the sheets before surface coatings are applied thereto.

In my copending applications Serial No. 196,959, filed June 6th, 1927, and Serial No. 228,332, filed October 24th, 1927, I have disclosed novel forms of apparatus wherein the scale and other foreign material on metal sheets efficiently may be removed by subjecting the sheets to the action of abrasive blasts while the sheets are moved through the apparatus in a horizontal position. In the apparatus referred to, the sheets are supported for movement through the apparatus by suitable rollers, and movement of the sheets is effected by causing them to pass between positively driven pinch rolls. Obviously when the sheets are subjected to the impacting of the abrasive material thereagainst, this material is forced outwardly over the surfaces of the sheets, and it has been found that the rather firm contact between the surfaces of the sheets, and the supporting rollers and pinch rolls causes some of the abrasive particles to be slightly embedded in the sheets. Thus it has been found that the abrasive particles sometimes slightly mar the sheets, rendering it somewhat undesirable to use the sheets thus marred for high class work where a perfect polished surface is desired, though for all purposes the sheets are more evenly, smoothly and perfectly cleaned than can be done with the pickling baths referred to.

The present invention contemplates a method for cleaning metal sheets wherein the weights of the sheets are wholly supported and the sheets are caused to travel through the apparatus by engagement wholly with edge portions thereof to prevent the abrasive particles from being forced into the surfaces of the sheets.

An important object of the invention is to provide a method of cleaning metal sheets by supporting them in vertical position and causing them to travel in such position past abrasive nozzles which are adapted to impact abrasive material against the surfaces of the sheets.

A further object is to provide a method of the character referred to wherein the weight of each successive sheet is supported wholly at the bottom edge thereof thus making it unnecessary to subject the surfaces of the sheets to any pressures which might cause abrasive particles to be forced into the surfaces of the sheets.

A further object is to provide a novel apparatus including means for causing successive sheets to travel in vertical position past suitable abrasive nozzles for impacting abrasive material against the surfaces of the sheets.

A further object is to provide horizontal conveying means upon which the vertically arranged sheets are adapted to be supported at their lower edges for movement past the abrasive nozzles.

A further object is to provide apparatus of the character referred to wherein the conveying means is supplemented by guide belts which are adapted to contact lightly with the surfaces of the sheets to maintain the latter in vertical position during their movement through the apparatus.

A further object is to provide an apparatus of the character referred to including a casing in which the sheet supporting, conveying and guiding means are arranged, and to provide for the various shafts employed in connection with the means referred to, suitable supporting bearings which are arranged wholly outwardly of the casing so as not to be subjected to the action of abrasive from the impacting nozzles.

A further object is to provide an apparatus of the character referred to wherein a pair of sets of vertically arranged nozzles are employed for impacting abrasive material against the surfaces of sheets passing between the sets of nozzles.

A further object is to provide novel means for returning the abrasive material from the bottom of the casing to the source.

A further object is to provide novel horizontal conveying means for the sheets and upon which the latter are adapted to be supported in vertical position for movement through the apparatus, the conveying means being adapted to collect abrasive material from the bottom of the casing after it has been discharged from the abrasive nozzles and to return the abrasive to the source.

A further object is to provide novel abrasive impacting means and supporting and driving means therefor.

Other objects and advantages of the invention will become apparent during the course of the following description.

In the drawings I have shown one embodiment of the invention. In this showing,

Figure 1 is a side elevation,

Figure 2 is a central vertical longitudinal sectional view,

Figure 3 is a similar view enlarged, showing the central portion of the apparatus,

Figure 4 is a transverse vertical sectional view on line 4—4 of Figure 1,

Figure 5 is a similar view on line 5—5 of Figure 1.

Figure 6 is a similar view on line 6—6 of Figure 2,

Figure 7 is a horizontal sectional view on line 7—7 of Figure 1,

Figure 8 is a detail elevation of a portion of the impacting apparatus, parts being shown in section,

Figure 9 is a detail section on line 9—9 of Figure 8,

Figure 10 is a detail section on line 10—10 of Figure 1,

Figure 11 is a similar view on line 11—11 of Figure 1,

Figure 12 is a similar view of line 12—12 of Figure 7,

Figure 13 is a horizontal sectional view, and,

Figure 14 is a fragmentary plan view of a modified form of the apparatus, parts being shown in section.

Referring to the drawings, the numerals 10 and 11 designate a pair of casing sections arranged toward the inlet and outlet ends of the apparatus respectively, as will become apparent. The casing sections are relatively narrow and are connected at their inner ends by a casing section 12, which is relatively wide for a purpose to be described. Each casing section 10 and 11 includes a plurality of vertical supports 13, and each of these supports is preferably T-shaped in cross section providing a base flange 14 and an outstanding rib 15. Side plates 16 are seated against the base flanges 14 to form closures for the side portions of the end casing sections. At the ends of these sections, substantially L-shaped sheets are arranged having side portions 17 and end portions 18, the latter defining the ends of the casing sections and being spaced apart as at 19 to permit the introduction of a sheet into the casing in a manner to be described. The supports 13 may be secured to the adjacent sheets of the casing by bolts or the like 20, whereby it will be apparent that the cover sheets are adapted to be removed when desired. The end openings 19 are normally closed by overlapping flaps 21, as shown in detail in Figure 11, the entering edge of each sheet being adapted to open the flaps to permit the sheet to enter and leave the casing.

The central widened portion of the casing is formed of a plurality of sheets 22 which are substantially L-shaped and are secured at their inner edges to the bases 14 of the inner supports 13. The outer edges of the plates 22 are secured to vertical supports 23.

Means are provided for conveying successive sheets of metal through the apparatus while standing vertically on one edge thereof. Referring to Figures 2 and 3, the numeral 24 designates a plurality of horizontal shafts extending across the lower portion of each casing section 10 and 11. Each of these shafts extends through the side walls of the casing and is journalled in bearings 25 mounted wholly outside the casing, as shown in Figures 1 and 5. Each shaft is provided with a roller 26, and a belt 27 passes around the rollers in each of the end sections. It will be apparent that the inner ends of the belts 27 are spaced from each other, as shown in Figure 3, for a purpose to be described.

Each casing section 10 and 11 is provided with a horizontal bottom wall 28, and the lower run of each of the belts referred to is slightly spaced above this lower wall. The belt 27 toward the inlet side of the apparatus is provided with a plurality of sheet supports 29 which are substantially Z-shaped as shown in Figure 3. One base of each of the sheet supports is secured to the belt, while the remaining portion which is substantially right angular in shape, projects outwardly from the belt. The outer extremity of each of the elements referred to is adapted to travel in proximity to the bottom plate 28 for a purpose to be described. The other belt 27 also is provided with a plurality of sheet supports 30 which are somewhat different from the corresponding elements previously described. The supports 30 are provided with U-shaped portions which project outwardly from the belt and base portions which are secured to the belt, as shown in Figure 3. The outer

faces of the supports 30 in the lower run of the corresponding belt travel in proximity to the bottom of the casing section 11.

As shown in Figure 5, the shafts 24 may be supported upon rails 31 arranged outwardly of the sides of the casing sections 10 and 11. The outermost shaft 24 arranged within the casing section 11 is extended at one end and is provided with a bevel gear 32, as shown in Figure 13. This gear meshes with a similar gear 33 carried by a shaft 34. Any suitable means may be provided for slowly driving the shaft 34. In the present instance a motor 35 is shown, this motor being connected by gears 36 and 37 with any suitable form of variable speed drive 38 such as the commercially well known "Reeves unit". The variable speed transmission may be connected by a belt 39 to suitable reduction gearing 40, to which the shaft 34, in turn, is connected.

The innermost shaft 24 at the inlet end of the apparatus extends through the outer extremities of the plates 22 and one end of the shaft is provided with a gear 41. This gear is driven in a manner similar to the gear 32 previously described, and the particular drive means therefore need not be referred to in detail.

Means are provided for retaining the sheets in vertical position as they travel through the apparatus. As shown in Figures 2, 3, 5 and 13, a pair of spaced shafts 42 is vertically arranged in the outer end of each of the casing sections 10 and 11, and also within the central casing section 12. Each of the vertical shafts is provided with upper and lower pulleys 43, and belts 44 pass around these pulleys. It will be obvious that the inner runs of the upper and lower belts 44 are spaced from each other a distance greater than the thickness of the sheets to be passed through the apparatus so that they do not bear against the surfaces of the sheets to any extent. The shafts 42 are adapted to be driven in such a manner that the inner runs of the belts 44 will travel at a linear speed equal to the speed of the belts 27. Thus it will be apparent that the inner runs of the belts 44 will travel at a speed equal to the speed of travel of the individual sheets, and hence will not slide with respect to the sheets to introduce any friction which might mar the surfaces thereof.

The supports 13 extend upwardly a substantial distance above the casing as clearly shown in Figures 1, 2, 3 and 5, and are curved inwardly at their upper ends. The portions of these supports above the casing are provided with bearings 45 which rotatably receive the shafts 42. The upper end of each shaft 42 is provided with a gear 46, and the gear 46 of each shaft 42 meshes with a similar gear 47 carried by the upper end of the adjacent shaft 42. The gears 46 and 47 are provided with hubs 48 which act as thrust bearings to contact with the upper ends of the bearings 45, and thus support the shafts 42 in position. Each support 13 also is provided with projections 49 and 50 at points adjacent the tops of the supports, and just above the casing, as shown in Figure 5. Upper and lower rails 51 and 52 are bolted to the projections 49 and 50, as at 53. These rails are relatively heavy and serve to rigidly connect the supports 13 to prevent any distortion thereof.

One of the shafts 42 at the inner end of the casing section 10 and one of the corresponding shafts adjacent the outer end of the casing section 11, is each provided with a bevel gear 54 meshing with a second bevel gear 55, the latter being carried by a horizontal shaft 56 journalled in a bearing 57. The latter bearings are carried by certain of the supports 13, as will be clear from an examination of Figure 5. Referring to Figure 3, any desired variable speed means 58, similar to that previously described, may be connected to a suitable source of power such as an electric motor, not shown, to provide power for driving the shafts 42. The variable speed unit may be connected by a belt 59 to suitable speed reduction gearing 60 and the shaft 56 is, in turn, connected to the gearing 60. The drive means for the belts 27 and 44 are preferably provided in the manner referred to so that the upper runs of the belts 27, and the inner runs of the belts 44 may be held taut by their respective drive means.

Means are provided for impacting abrasive material against the surfaces of the sheets as they pass through the casing section 12. Referring to Figures 4 and 13, the numeral 61 designates a pair of vertically arranged spaced shafts which are preferably square in cross section. These shafts extend upwardly through relatively large openings 62 formed in the top 63 of the central casing section. Flexible elements 64, preferably in the form of leather, are secured at their outer edges to the top 63 around the openings 62, and are secured at their inner edges to the shafts 61 by clamping bands 65 or the like. It will be apparent that the flexible elements form closures for the openings 62 but are adapted to permit vertical reciprocation of the shafts 61. The central supports 23 extend inwardly over the casing top 63, as at 66, and then extend vertically as at 67. Pairs of guides 68 having guide grooves 69 therein, are arranged between the vertical extensions 67 and are bolted thereto as at 70. A pair of plates 71 is slidable in each pair of guides 68, and each of these plates is provided with a central opening through which one of the shafts 61 extends. Each plate 71 is provided with a plurality of ears 72 between which are journalled rollers 73, the rollers above and below each plate being arranged to correspond to the cross sectional shapes of the shafts 61 to serve as guides for the shafts to

permit the latter to reciprocate in fixed relative positions. A transverse shaft 73 is journalled in bearings 74 carried by the upper extremities of the supports 23 and this shaft is adapted to be driven from any suitable source of power. The shaft 73 is provided with a pair of eccentrics 75 each of which is surrounded by a band 76 carrying a pair of depending ears 77 at its lower end. The upper end of each shaft 61 is flattened and extended upwardly as at 78 for reception between one pair of ears 77, and is pivotally connected thereto by a pin 79. It will be apparent that the shaft 73 is adapted to be rotated at a low speed to vertically reciprocate the shafts 61, these shafts being held in fixed relative positions by means of the guide rollers 72. If desired, the shafts 61 may be mounted for adjustment toward and away from each other to vary the effect of the impacting of the abrasive against the surfaces of the sheets in a manner to be described. To secure the adjustment referred to, the eccentrics 75 may be splined to the shaft 73, as at 80, whereby it will be apparent that the eccentrics are adapted to be arranged in selected positions along the shaft 73, within reasonable limits. The vertical extensions 67 may be provided with adjusting screws 81 threaded at their inner ends in the plates 71, whereby it will be apparent that the latter elements may be moved toward or away from each other together with the shafts 61.

Each shaft 61 is provided with a plurality of abrasive impacting manifolds 82. As shown in Figures 3 and 4, it is preferred that an even number of manifolds be used in connection with each shaft and that half the manifolds be arranged on one side of the shaft and the remaining manifolds on the opposite side in order to balance the weight on the shaft and thus provide for smoother reciprocation thereof. In connection with this feature, it is pointed out that the shafts 61 are supported wholly without the casing to prevent any abrasive material from coming in contact with any of the bearings or driving means for the shafts 61, and the fact that the shafts 61 are wholly unsupported within the casing makes it desirable that the weights carried by these shafts be balanced. Each manifold is relatively flat, as shown in Figure 9, and is flared vertically as at 83 to provide a vertically elongated inner wall 84, as shown in Figure 8. The latter wall is provided with a plurality of openings 85 communicating with threaded connections 86 having flanges 87 bolted to the wall 84 as at 88. Each connection 86 is provided at its outer end with an abrasive impacting nozzle 89 which is secured to one of the connections 86 by a cap 90. The outer end of each manifold is cylindrical as indicated at 91 and is adapted to be connected to a flexible hose 92 by a clamp 93. As previously stated, the shafts 61 are preferably square in cross section, and in order to secure the manifolds against the shafts, it is preferred that the latter be provided with flattened portions 94 against which seat bosses 95 cast integral with the manifolds. Screws 96 are adapted to pass through the shafts 91 and into the bosses 95 to secure the manifolds in position. It will be apparent, however, that any suitable means may be employed for supporting the manifolds.

Each of the flexible connections communicates at its outer end with a short pipe section 97, being secured thereto by a suitable clamping band 98. The pipe sections 97 extend through openings formed in the casing sections 22 and in the supports 23. As previously stated, the central casing section is materially wider than the end sections, and this increase in width is provided to accommodate the manifolds 82 and to permit the use of flexible connections 92 of sufficient length to allow for the reciprocation of the manifolds. The outer ends of the connections 97 carry four-way connections 99, one branch of each of the latter connections being connected to a depending flexible hose 100. The other branches of the connections 99 are provided with plugs 101 for a purpose to be described.

Novel means are provided for supplying abrasive material under pressure to the manifolds to be impacted against the surfaces of sheets passing therebetween. Referring to Figure 3, the numeral 102 designates a preferably cylindrical vertically arranged tank disposed beneath the central casing section. The upper end of the tank is open and is provided with a depending cone 103 forming an abrasive receiving hopper. The upper end of the tank connects directly to the bottom walls 28 of the casing, as clearly shown. The lower end of the hopper 103 is provided with a valve 104 pivotally supported by a shaft 105 mounted in a bracket 106 carried by the hopper 103. The valve 104 is normally closed to prevent communication between the hopper and the space therebeneath. The shaft 105 extends through the tank 102 and is provided outwardly thereof with an arm 107 adapted to contact with a rotatable cam 108 carried by a shaft 109. A second cone 110 is arranged within the tank 102 beneath the hopper 103 and forms therewith an intermediate tank 111 for a purpose to be described. The cone 110 also is provided at its lower end with a valve 112 similar to the valve 104. The valve 112 is fixed to a shaft 113 pivotally supported on a bracket 114 carried by the cone 110. The shaft 113 extends through the tank 102 and is provided with an arm 115 which also contacts with the cam 108. It will be apparent that as the shaft 109 is slowly rotated, the cam 108 will succes-

sively rock the arms 107 and 115 to alternately open and close the valves 104 and 112.

The bottom of the tank 102 is closed by a head 116, and a portion of the tank beneath the cone 110 forms a pressure chamber 117 to which air or other fluid under pressure is adapted to be delivered through a pipe 118 connected to a suitable source of fluid pressure supply. Referring to Figures 3 and 12, the wall of the tank 102 near the lower end thereof is provided on opposite sides of the tank with a plurality of preferably circular openings 118 corresponding in number to the number of manifolds 82. A mixing chamber 119 is mounted against the wall of the tank and covers each of the openings 118. The inner walls of the chambers 119 are curved to conform to the shape of the tank 102 and are bolted thereto as at 120. The inner wall of each chamber 119 is provided with a spider 121 between the arms of which the chamber communicates with the lower portion of the tank 102. The center of each spider is solid as at 122 and receives the threaded outwardly turned lower end of an upstanding pipe 123, the latter pipe having perforations 124 therein. The lower end of each of the depending flexible hoses 100 connects to one of the chambers 119, as shown in Figure 12. Each mixing chamber is provided with a supplemental fluid supply opening 125 which connects to a pipe 126, as shown in Figure 7, the pipes 126 on each side of the tank 102 communicating with a manifold or header 127 leading from the source of fluid pressure supply.

Referring to Figures 2 and 6, the numeral 128 designates a plurality of supporting rollers journalled in bearings 129 which may be supported on rails 130. The rollers 128 are arranged parallel to each other transversely of the apparatus, and extend toward the inlet end of the apparatus to assist in feeding sheets thereinto. Each roller 128 is provided with a bevel gear 131 meshing with a similar gear 132 secured to a shaft 133 which may be driven in any suitable manner to rotate the rollers 128. Each roller 128 is provided with a peripheral groove 134 adapted to receive the lower edge of each successive sheet 135 as the latter is fed into the inlet end of the casing through the opening 19. As shown in Figure 6, the grooves 134 are arranged in alinement with each other and with the opening 19. Adjacent the rollers 128 a plurality of upstanding brackets 136 is arranged, each bracket supporting a roller 137 journalled on a pin 138 passing through ears 139 preferably formed integral with the support. It will be obvious that the sheets are adapted to be supported momentarily in vertical position against the rollers 137 until the forward portions of the sheets are fed into the inlet end of the casing to be conveyed by the belt 27 and sheet supports 29. Rollers 140 are arranged adjacent the outlet side of the apparatus to support the sheets discharged therefrom, and these rollers are similar to the rollers 128 and need not be referred to in detail. Vertical rollers 141 are also arranged adjacent the outlet side of the apparatus and a belt 141′ passes around these rollers to assist in supporting the discharged sheets in position. Means may be provided for supporting the packs of sheets adjacent the inlet and outlet ends of the apparatus to facilitate the handling of the sheets. Referring to Figure 1, the numerals 142 and 143 designate a pair of platforms arranged adjacent and slightly to one side of the inlet and outlet ends of the apparatus respectively. Each platform is supported on the upper end of a pair of vertical screws 144 mounted in supporting posts 145. Each screw is threaded through a worm wheel 146 meshing with a worm 147 carried by a longitudinally extending shaft 148. The shaft is adapted to be driven by a gear 149 through a suitable clutch 150 which may be controlled in any suitable manner. The pinion 151 meshes with the gear 150 and is driven by a suitable motor 152.

It will be apparent that as abrasive material is impacted against the sheets it will spread out toward the ends of the casing, but due to the length of the end sections thereof, most of the abrasive will lose its momentum and drop to the bottom of the casing before reaching the ends thereof. The escape of abrasive material from the casing is minimized by provision of the flaps 21, but additional means for this purpose may be provided. Referring to Figure 1, the numeral 153 designates a vertical pipe communicating with each casing section 10 and 11. These pipes are adapted for connection with a suitable source of suction such as a centrifugal blower, and they tend to counteract the pressure discharged into the casing with the abrasive material, and thus minimize or reduce the velocity of the abrasive particles after they strike the surfaces of the sheets. The suction created by the pipes 153 also tends to carry off lighter particles of the material in the casing, such as fine particles of scale and the like which is materially lighter than the abrasive material. In this connection, it is noted that any suitable abrasive may be employed, but it is preferred that fine steel particles be used, and these particles are relatively heavy and will be unaffected by the vacuum within the pipes 153.

In Figure 14 of the drawings I have shown a somewhat modified adaptation of the apparatus. It is becoming the practice in the manufacture of sheet metal to economize on space as much as possible and accordingly sheets are now being manufactured in relatively long lengths and reeled prior to being

subjected to the action of a pickling bath. With such a practice, much longer sheets can be made than with the old method of making flat sheets, and the resulting sheets require less room in the pickling bath and in storage. The form of the apparatus illustrated in Figure 14 is identical with that previously described except that the means for supporting and feeding the sheets to the apparatus is eliminated and suitable means is substituted therefor for feeding the sheets to the apparatus and coiling the long sheets fed therefrom. Referring to Figure 14, the numeral 154 designates a reel of metal coiled about a suitable spool 155 which may be supported vertically for rotation in any suitable manner. The end of the sheet is fed to the inlet end of the apparatus between pinch rolls 156 which, it will be noted, are arranged wholly outwardly of the casing. The pinch rolls may be driven in any suitable manner, as will be apparent. Adjacent the outlet end of the apparatus, a collecting spool 157 is vertically arranged and is connected to a bevel gear 158 to be rotated thereby. A motor 159 is provided with a bevel pinion 160 meshing with the gear 158 to effect rotation thereof. The shaft of the motor 159 may be provided with a friction clutch 159′ to compensate for the difference in the linear speed of travel of the sheet as it winds upon the spool 157. The spool 157 is provided with a slot 161 adapted to receive the end of the sheet whereby it may be wound upon the spool 157.

The operation of the apparatus is as follows:

In the preferred form of the apparatus illustrated in Figures 1 to 13 inclusive, the packs of sheets to be cleaned are laid horizontally upon the platform 142, and the clutch 150 is engaged to rotate the shaft 148 and lower the platform until the top sheet of the pack is substantially at the level of the rolls 128. The lowering of the platform 142 simultaneously raises the platform 143 until the top thereof is substantially at the level of the rolls 140. The operator then slides the top sheet of the pack inwardly and swings the outer edge thereof upwardly, whereupon the lower edge of the sheet will engage in the grooves of the rollers 134 while the sheet lightly rests against the upper rollers 137 to prevent the sheet from swinging past a vertical position. The sheet is maintained in such vertical position by the operator, and rotation of the rollers 128 by their drive means referred to, causes the sheet to be fed into the casing section 10 through the opening 19. The entering edge of the sheets parts the flaps 21, these flaps lying snugly against the sides of the sheet to prevent abrasive material from escaping through the opening 19. The rolls 128 are driven at such a rate of speed that the linear travel of the inner portions of the grooves 134 is equal to the linear speed of the belts 27. The innermost portions of the grooves 134 are arranged at the level of the tops of the sheet supporting members 29 when the latter are in the upper arm of their associated belt 27, and thus it will be apparent that each successive sheet is fed into the apparatus and picked up by the first belt 27 to convey the sheets past the impacting nozzles. As the entering edge of the sheet passes the center of the apparatus, it will be picked up by the sheet supporting members 30 to be supported and conveyed thereby to the outlet end of the apparatus. Obviously both of the belts 27 will be driven at the same speed. As previously stated, the inner runs of the belts 44 are spaced apart a distance slightly greater than the thickness of the sheets and accordingly it will be apparent that these belts do not grip the sheets, but merely prevent them from falling, the entire weights of the sheets being supported by the conveying belts. Thus the belts 44 will not cause any of the abrasive material to become embedded in the surfaces of the sheets to mar the latter.

As each sheet passes the central portion of the casing, both surfaces of the sheets will be subjected to the action of abrasive from the nozzles 89. The abrasive material flows between the arms of the spiders 121 to the mixing chambers 119, and air under pressure will be supplied to these chambers through the pipes 123. The compressed air mixes with the abrasive material in the chambers 119 and forces the material upwardly through the flexible hoses 100 to the pipe sections 97. The four-way connections 99 are preferably employed in place of elbows, since the abrasive material travels upwardly through the hoses 100 at a high velocity and would rapidly wear the elbows. With the construction employed, the impact is taken up by the upper plugs 101 which readily may be replaced when worn. The outer plugs 101 are provided merely for convenience in permitting the pipes to be cleaned out. The abrasive material will be delivered to the manifolds through the flexible connections 92 and will be discharged from the manifolds through the nozzles 89 thereof. Owing to the tendency of the abrasive material to travel in a straight path from the cylindrical neck 91 of each manifold to the central portion of the wall 84, there is a natural tendency for the central nozzles of each manifold to deliver a greater quantity of abrasive to the sheets than do the outer nozzles. This readily may be compensated for by employing nozzles the bores of which progressively increase in size toward the extremities of the manifolds. In the drawings, four manifolds have been shown connected to each of the square shafts 91, and accordingly four mixing chambers 119 have been shown connected to each side of the tank 102, one mixing cham-

ber being provided for each of the manifolds. It will be obvious, however, that any suitable number of manifolds and associated elements may be employed. The use of the supplemental air pipes 126 associated with the mixing chambers is not essential, but they tend to assist in forcing the abrasive material through the hoses 100, and also tend to prevent the abrasive material from becoming packed in the mixing chambers.

During the impacting action referred to, the shafts 61 are reciprocated to cause the nozzles 89 to move transversely with respect to the sheets traveling therebetween. The shaft 73 is slowly rotated, and this rotation is imparted to the eccentric 75 to transmit a reciprocating movement to the shafts 61 through the pivot pins 79. It will be noted that the eccentrics 75 are oppositely mounted thus tending to balance lateral strains on the shaft 73, while the weights of the manifolds are divided with respect to the shafts by arranging the manifolds on opposite sides thereof. The structure defined tends to render the operation of the reciprocating means much smoother thus lengthening the life of the parts and requiring less power for the operation thereof. The rollers 73 prevent the shafts 61 from turning, thus holding the impacting nozzles in the proper angular position with respect to the sheets. The distance of the nozzles from the sheets may be varied within reasonable limits by operating the screws 81 and by sliding the eccentrics 75 with respect to the shaft 73.

A large portion of the abrasive material discharged from the nozzles will flow downwardly between the ends of the belts 27, and into the hopper 103. Some of the abrasive material will be carried toward the outlet ends of the casing due to the velocity of the particles but the momentum of the particles will be greatly overcome before they reach the ends of the casing whereby most of the particles will fall from the bottom of the casing sections 10 and 11 before reaching the outer extremities thereof. The material falling upon the belt 27 of the casing section 10 will be conveyed by the upper run thereof to the center of the apparatus where it will be dumped into the hopper 103. The bottoms of the casing sections 10 and 11 preferably slope, as shown in Figure 5, whereby the abrasive material discharged into the bottoms of these casing sections outwardly of the belts 27 will flow downwardly toward the belts to be picked up thereby. The sheet supporting members 29 act as cups to take up the abrasive material from the bottom of the casing section 10 and carry it over the top run of the belt to return it to the hopper 103. The material falling directly into the bottom of the casing section 11 will be scraped along the bottom 28 thereof to be returned directly to the hopper, while the portion falling on the top of the belt 27 of the casing section 11 will be carried over by the members 30 at the outer end of the casing section and thus will be conveyed along the bottom 28 and returned to the hopper 103. The flaps 21 tend to prevent the abrasive material from being forced out of the casing through the openings 19, and this action is assisted in by the provision of the vacuum pipes 153. Thus it will be apparent that practically all of the abrasive material is returned to the hopper 103 after being impacted against the sheets. Thus it will be apparent that all of the abrasive material is retained within the casing, and since all of the bearings employed in the apparatus are arranged outwardly of the casing, these bearings are wholly protected from the destructive action of the abrasive. This also is true of the various drive means employed, all of the gearing and other driving elements being arranged wholly outwardly of the casing.

It will be noted that each shaft 42 is connected to its associated shaft by means of the gears 46 and 47, and consequently the various shafts referred to are positively driven. The particular drive means employed for the various belts used in the apparatus is adapted to render the upper runs of the belts 27 and the inner runs of the belts 44 taut to prevent sagging thereof.

Abrasive material is periodically transferred from the hopper to the pressure chamber 117. As previously stated, the shaft 109 is slowly rotated whereby the cam 108 alternately swings the arms 107 and 117 to periodically open the valves 104 and 112. When the valve 112 is opened, as shown in Figure 3, the valve 104 is closed, and a pressure will be built up in the chamber 111 equal to that in the pressure chamber 117. When the pressures become equalized abrasive material in the chamber 111 will flow downwardly by gravity into the chamber 117. The valve 112 gradually closes as the cam 108 continues to rotate, and the cam then contacts with the arm 107 to swing the latter and open the valve 104. This action causes pressure to escape from the chamber 111 into the hopper 103, and when atmospheric pressure is reached in the chamber 111 abrasive material will flow from the hopper to the chamber 111 by gravity. This action is continued during the operation of the apparatus, and thus it will be apparent that as the abrasive is returned to the hopper 103 in the manner referred to, it periodically will be transferred to the chamber 117 so that it again may be used. Any suitable means may be employed for normally holding the valves 104 and 112 in closed position, as will be apparent. As successive sheets are fed into the apparatus, the controlling means for the platforms 142 and 143 may be operated to elevate the former to maintain the level of the top of the pack at the desired point. As

the sheets are discharged from the outlet end of the apparatus they are supported in horizontal position against the rollers 141 until each sheet is wholly discharged from the machine, whereupon it may be permitted to fall to a horizontal position upon the platform 143. As the pile of sheets upon this platform becomes higher, the platform may be lowered simultaneously with the raising of the platform 142.

The operation of the sheet cleaning apparatus shown in Figure 14 is identical with that previously described, and need not be referred to in detail. In this form of the apparatus, reels of sheet metal are placed in position at the inlet end of the apparatus, and the outer end of the sheet is introduced between the pinch rolls 156 whereby the sheets continuously may be fed into the apparatus. In connection with these pinch rolls, it will be noted that while they engage the sheet relatively firmly they are arranged wholly outwardly of the apparatus, and none of the abrasive material reaches these rollers to become embedded in the sheet. As the sheet is fed from the outlet end of the apparatus, the forward edge thereof is inserted in the slot 161 and the motor 159 is operated to rotate the spool and thus wind the sheet thereon. As previously stated, the friction clutch 159 is adapted to compensate for differences in the linear speed of the sheet as the latter is wound upon the spool 157. The linear speed of the spool itself obviously must be equal to the linear speed of the pinch rolls 156, and as the outside diameter of the sheet wound upon the spool 157 increases, the clutch 159′ is adapted to slip. After each spool 155 is emptied, a new spool may be placed in position, and similarly when a sheet is completely wound upon the reel 157, the latter may be replaced by an empty spool.

From the foregoing it will be apparent that the sheets are supported in vertical position by the lower conveyor belts and are not subjected to any side pressure, and thus it will be apparent that no abrasive material can become embedded in the surfaces of the sheets. The present invention, therefore, contemplates the method of cleaning sheet metal which consists in cleaning the sheets while in vertical position and supporting the weights of the sheets wholly upon one edge portion thereof. The invention also consists in the method of conveying the sheets while supporting them in the novel manner referred to. The resulting sheets have been found to be perfectly clean, and the sheets are relatively highly polished and are free from scratches, indentations, etc. Relatively heavy sheets cleaned in accordance with the present invention may be passed through drawing rolls to reduce the thickness of the sheets, and the resulting sheets will be very highly polished and will be wholly free from surface blemishes of any kind. Obviously no acid is left in the pores of the metal, and the cleaning action is so perfect that the sheets may be permitted to remain uncoated for a relatively long period of time without any corrosion appearing on the surfaces of the sheets.

It is to be understood that the forms of the invention herewith shown and described are to be taken as preferred examples of the same and that various changes in the shape, size and arrangement of parts may be resorted to without departing from the spirit of the invention or the scope of the subjoined claims.

I claim:

1. Apparatus of the character described comprising a casing through which a metal sheet is adapted to travel in a vertical position, said casing including a bottom wall, horizontal endless belt conveying means extending through the lower portion of said casing and adapted to engage the lower edge of the sheet to wholly support the weight thereof, means arranged on opposite sides of the path of travel of the sheet for impacting abrasive material against the surfaces of the sheet, a source of abrasive material for said impacting means, and means forming a part of said conveying means for collecting discharged abrasive material from the bottom wall of said casing and returning it to said source.

2. Apparatus constructed in accordance with claim 1 wherein said conveying means includes a plurality of horizontal shafts projecting transversely through said casing and having their ends arranged wholly outwardly thereof, and bearings for the ends of said shafts.

3. Apparatus constructed in accordance with claim 1 provided with endless belts arranged above said conveying means and having their inner runs spaced apart a distance at least as great as the thickness of the sheet and adapted to receive the sheet therebetween to maintain it in vertical position during its passage through said casing, a plurality of vertical shafts for supporting said belts, the upper ends of said shafts projecting through the top of said casing, and bearings adapted to rotatably support the upper ends of said shafts.

4. Apparatus constructed in accordance with claim 1 wherein said bottom wall is provided with downwardly sloping portions to direct the discharged abrasive material to said abrasive collecting means.

5. Apparatus of the character described comprising a casing having inlet and outlet openings through which a metal sheet is adapted to travel in vertical position, a pair of alined horizontal endless belt conveyors arranged in the lower portion of said casing and having their adjacent ends spaced from each other centrally of said casing, said conveyors being adapted to engage the lower

edge of the sheet to wholly support the weight thereof, means adapted to lightly engage the sheet to maintain it in vertical position during its passage through said casing, means arranged on each side of the path of travel of the sheet substantially centrally of the length of said casing for impacting abrasive material against the surfaces of the sheet, a source of abrasive material for said impacting means, a hopper arranged beneath said casing centrally thereof, and means for transferring abrasive material from said hopper to said source, said belt conveyors being provided with means adapted to travel along the bottom wall of said casing to collect discharged abrasive material therefrom and return it to said hopper.

6. Apparatus of the character described comprising a casing through which a metal sheet is adapted to travel in vertical position, means for conveying the sheet through said casing, a source of abrasive material, means for impacting abrasive from said source against opposite sides of the sheet during its movement through said casing, and means including said conveying means for returning discharged abrasive to said source.

7. Apparatus of the character described comprising a casing through which a metal sheet is adapted to travel in vertical position, means for conveying the sheet through said casing, a plurality of nozzles adapted to impact abrasive material against opposite sides of the sheet as it passes through said casing, a source of abrasive for said nozzles, and means for returning discharged abrasive to said source including said conveying means and operative along the bottom of said casing.

In testimony whereof I affix my signature.

HAROLD E. McCRERY.