N. E. CLARK.

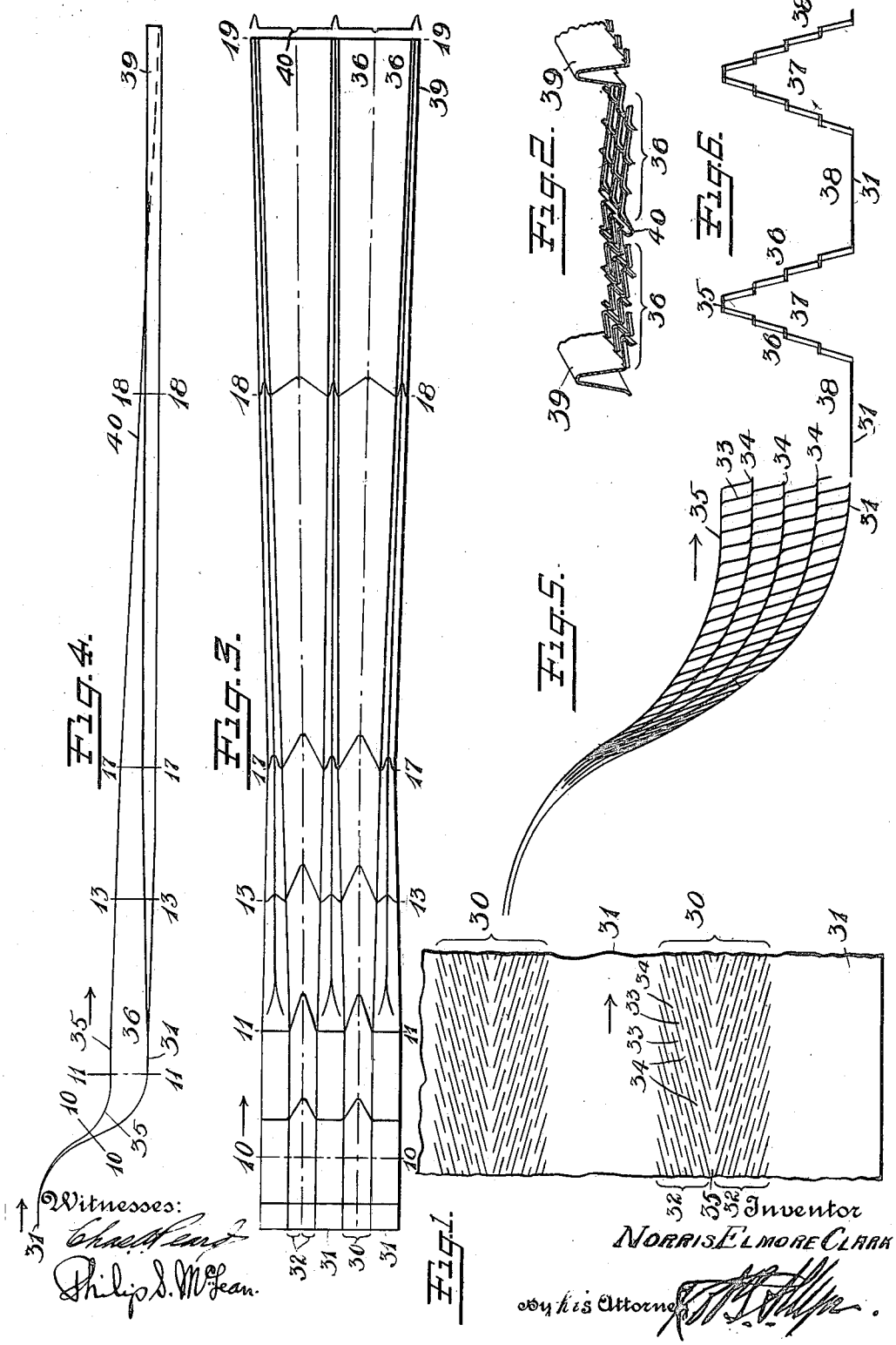
METAL WORKING.

APPLICATION FILED OCT. 28, 1914.

1,146,553.

Patented July 13, 1915.

6 SHEETS—SHEET 1.



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by his Attorney

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6 SHEETS—SHEET 2.

Fig. 8.

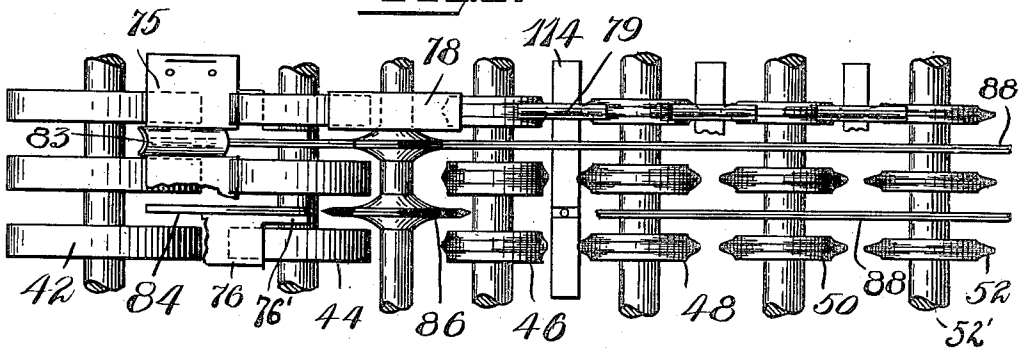
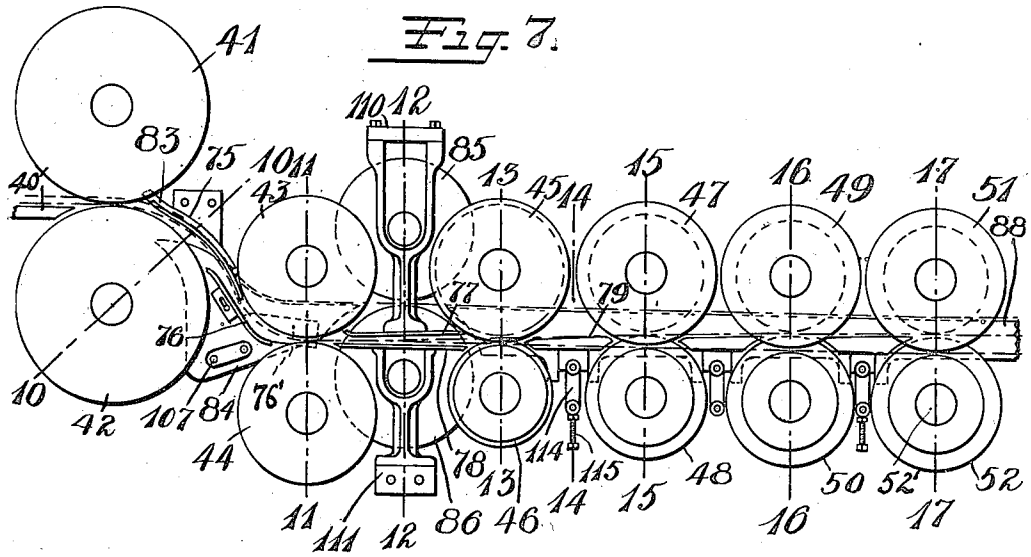


Fig. 7.



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6 SHEETS—SHEET 3.

Fig. 9.

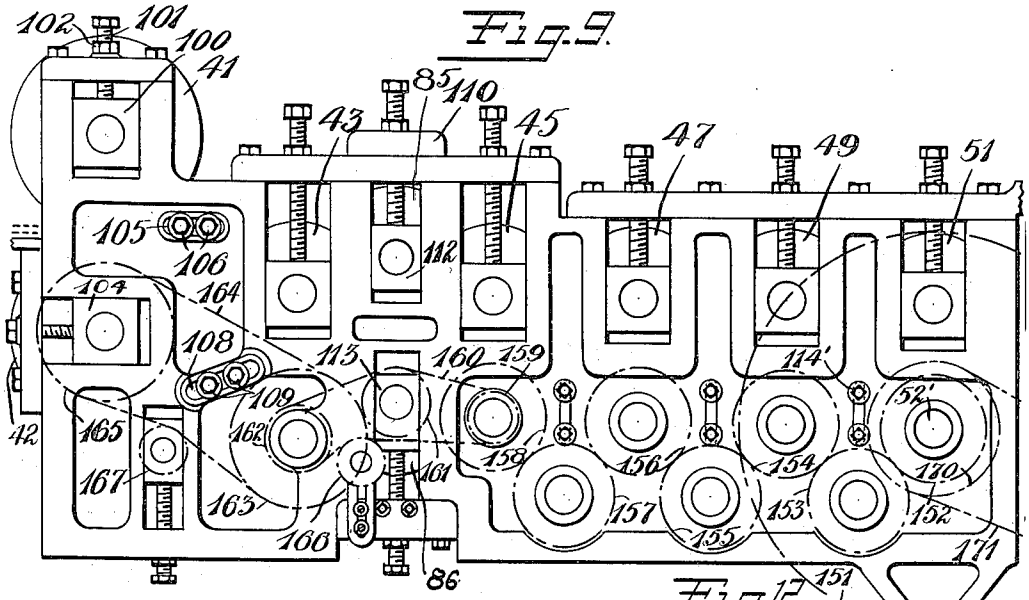


Fig. 10.

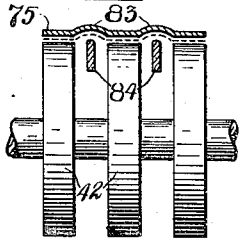


Fig. 11.

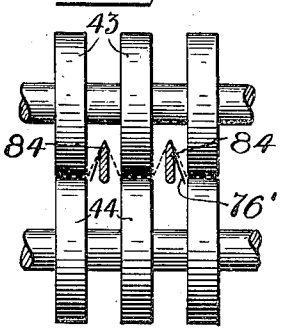


Fig. 12.

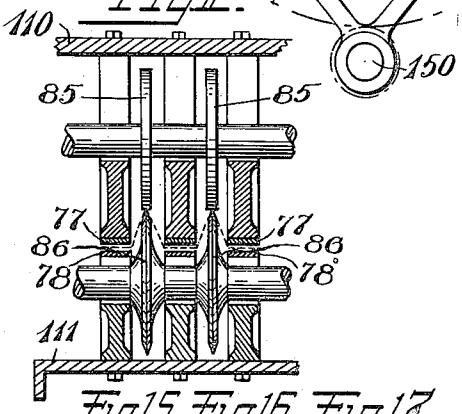


Fig. 13.

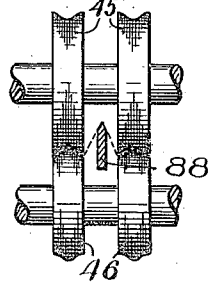


Fig. 14.

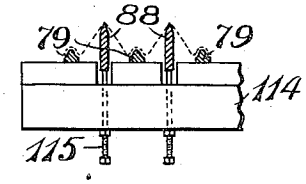
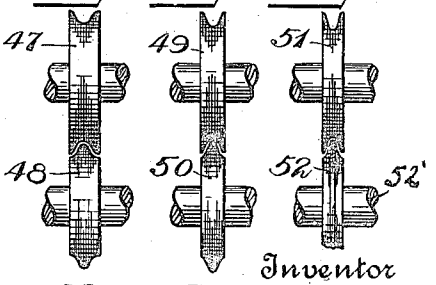


Fig. 15. Fig. 16. Fig. 17.



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6 SHEETS—SHEET 4.

Fig. 19.

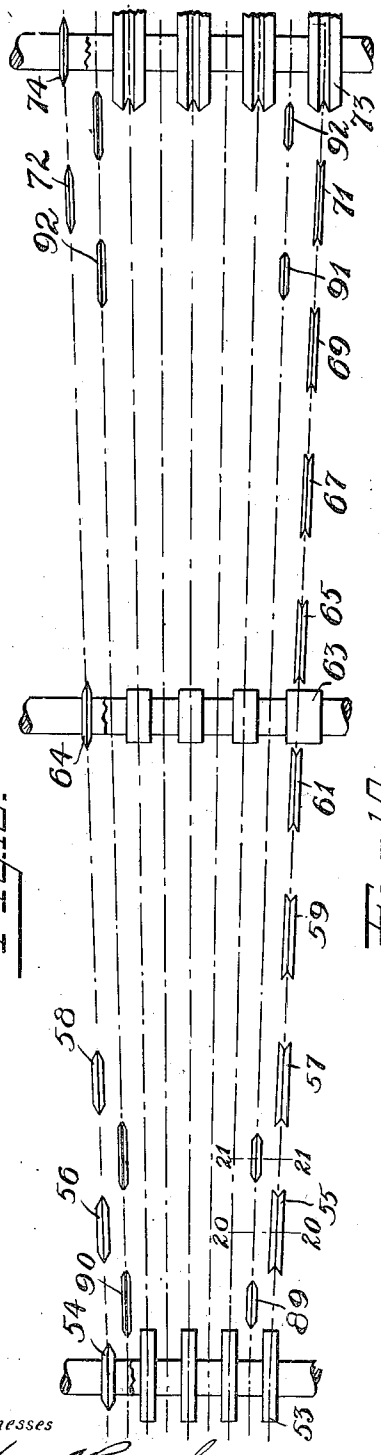
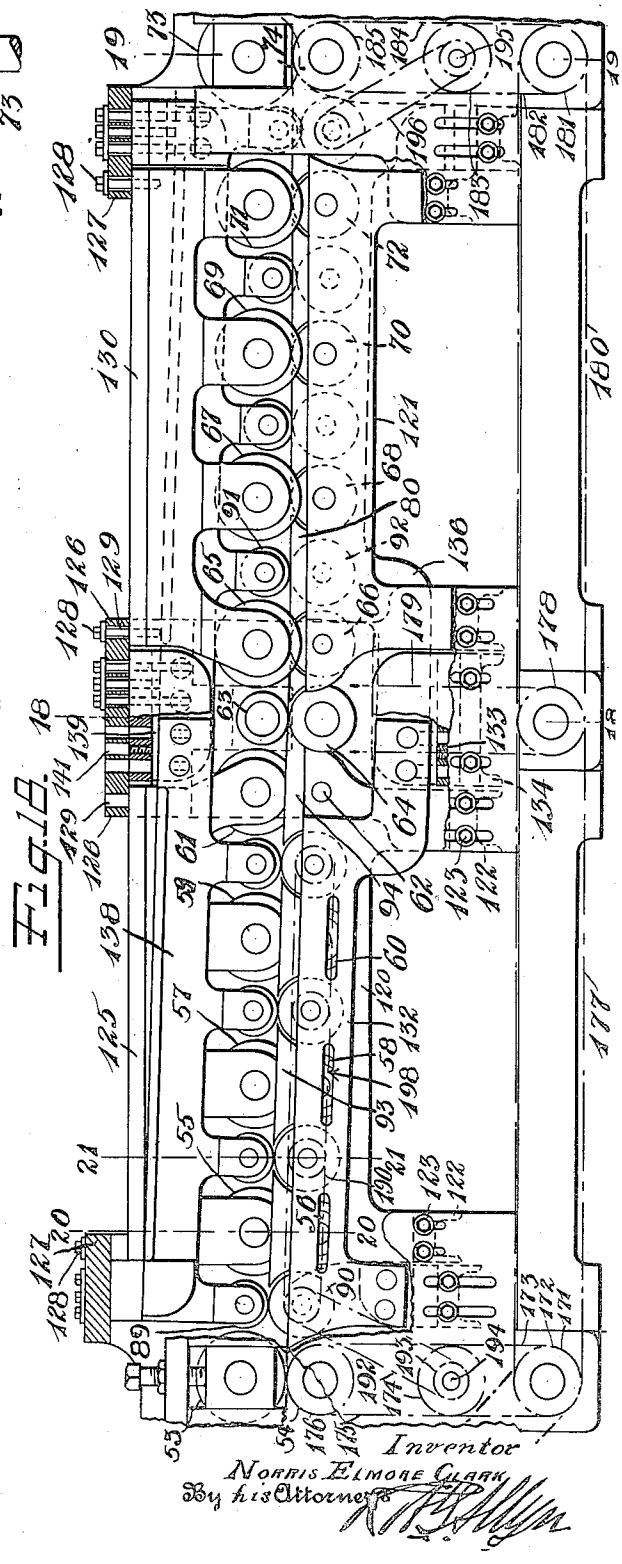


Fig. 18.



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6 SHEETS—SHEET 5.

Fig. 20.

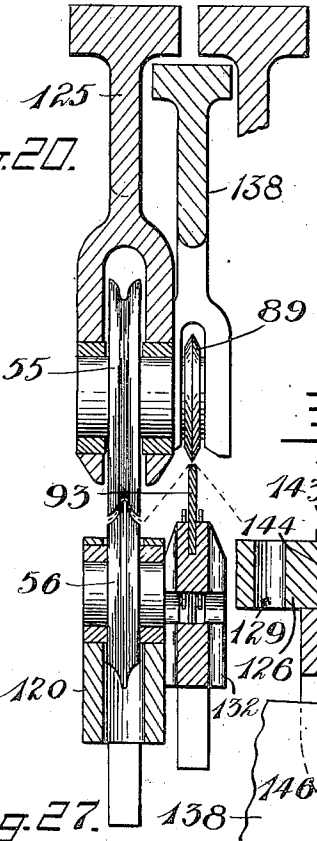


Fig. 21.

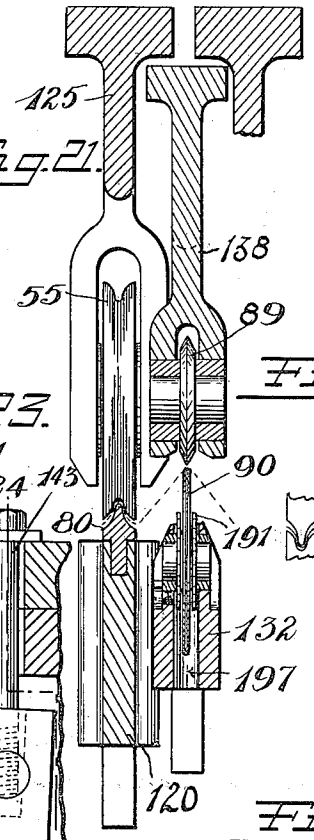


Fig. 23.

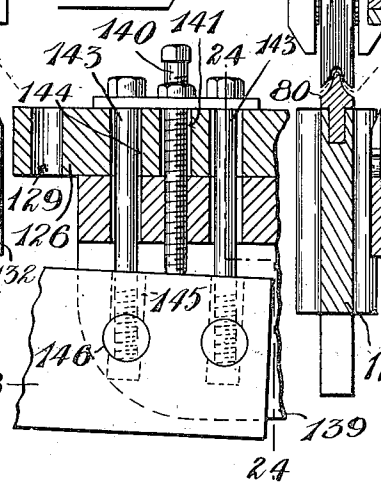


Fig. 25.

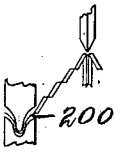


Fig. 27.

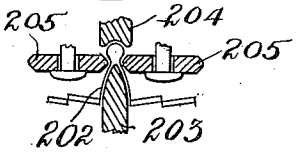


Fig. 26.

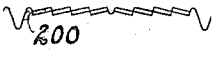


Fig. 22.

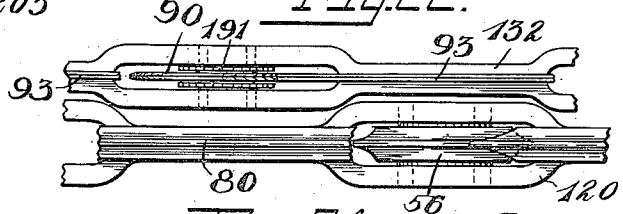
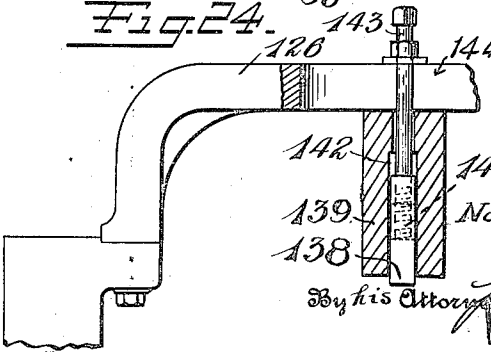


Fig. 24.



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METAL WORKING.

APPLICATION FILED OCT. 28, 1914.

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Patented July 13, 1915.

6 SHEETS—SHEET 6.

Fig. 28.

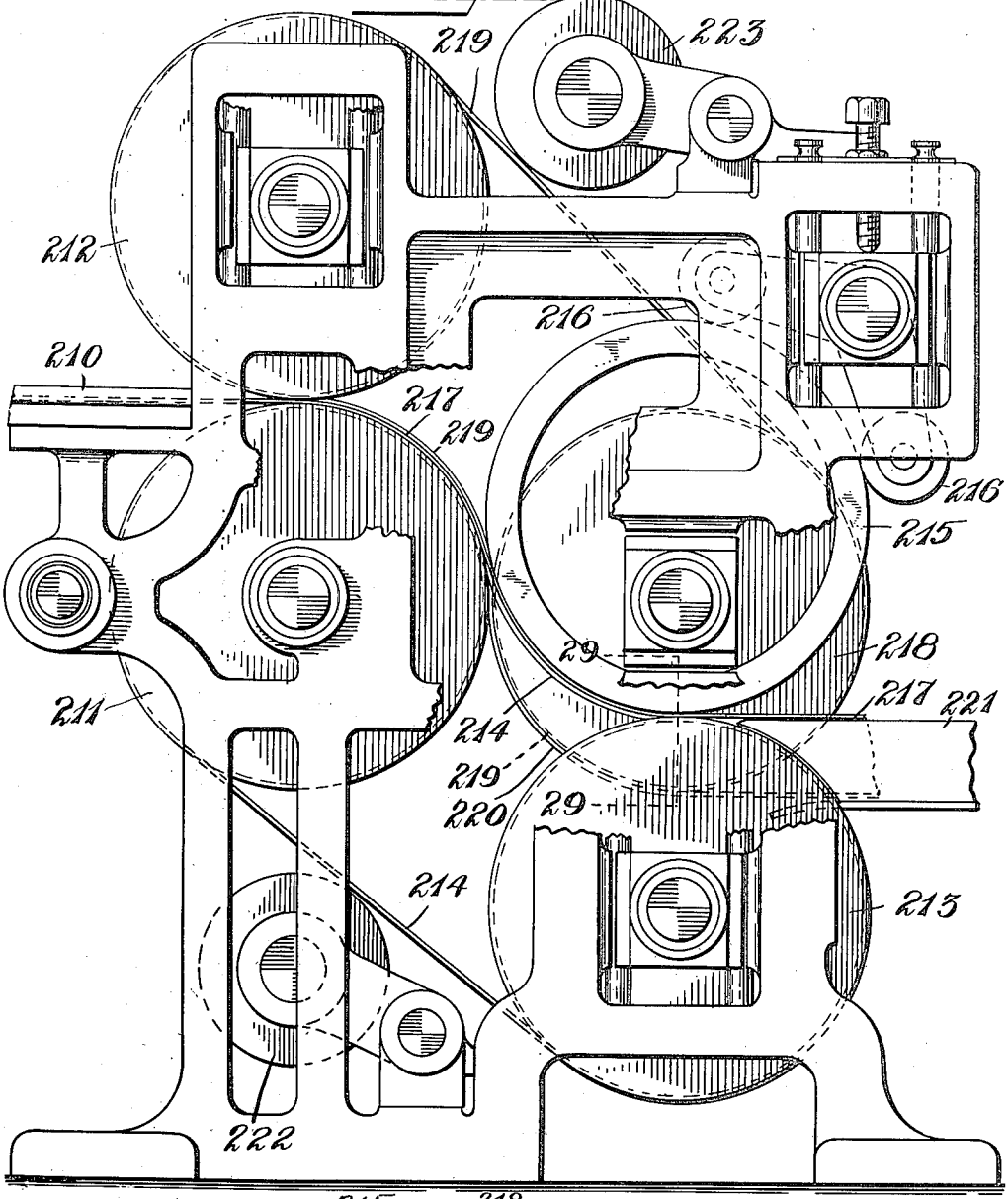
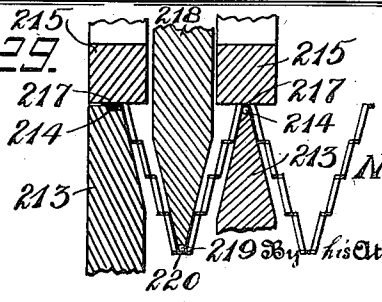


Fig. 29.



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UNITED STATES PATENT OFFICE.

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METAL-WORKING.

1,146,553. Specification of Letters Patent. Patented July 13, 1915.

Application filed October 28, 1914. Serial No. 869,025.

To all whom it may concern:

Be it known that I, NORRIS ELMORE CLARK, a citizen of the United States of America, and residing at Plainville, in the county of Hartford and State of Connecticut, have invented new and useful Improvements in Metal-Working, of which the following is a specification.

My invention relates to the manufacture of expanded metal suitable for lathing and cement or concrete reinforcement such for instance, as is shown in my Patent #930,350 dated August 10, 1909 and with particular reference to deep ribbed reinforced expanded metal as shown in my Patent #1,128,659 dated February 16, 1915. Certain features of the general method of manufacture are disclosed in my Patents #979,130 dated December 20, 1910 and #1,052,888 dated February 11, 1913.

The main object of this invention is to provide means for carrying out a method of manufacture, which shall be economical, as to speed of operation, labor costs, cost of up-keep of the machinery, power required to operate and safety to the operators.

A further object is to carry out a method of producing a stiff rigid product of perfect formation in such a manner that at no time during the process are any parts of the connecting members or of the longitudinal portions weakened or materially stretched.

The present invention includes certain improvements in the method and mechanism found desirable in accomplishing the objects above outlined.

Briefly considered the method consists of first scoring, slitting or punching sections of a metal sheet, in such suitable manner as to provide strands connected in staggered arrangement and leave parallel longitudinally disposed unscored portions, preferably for instance, as shown in my Patent #979,130 and afterward corrugating the scored sections to form meshwork, corrugating the unscored portions or members to form ribs and flattening the meshwork into a common plane.

When desired to form deep beams or folded ribs, the unscored portions will naturally be left of sufficient width to allow for the corrugating action of the desired depth. The scoring should be in staggered arrangement and may be along diagonal lines. The diagonal lines in adjacent halves of each scored section may be oppositely disposed and when thus arranged, an intermediate unscored portion may be left along the center of each scored section.

The mechanism throughout consists of trains of disks or rolls and guides so that the sheet is first corrugated along the scored sections and then along the unscored portions and then the meshwork is subsequently spread out or flattened into a common plane.

The sheet when suitably scored is fed into corrugating mechanism, in which the scored sections are opened into meshwork. This corrugating action is accomplished by feeding the scored sheet downwardly and passing the main unscored members around curved disks or rolls and at the same time supporting the center of each scored section in such a manner as to permit the strands of the scored sections to bend naturally and gradually without buckling the unscored members. The centers of the scored sections pass around curves similar to those taken by the unscored members and slightly in advance thereof so as to effect a longitudinal movement of the center of each scored section relative to the unscored members. When desired to form a ribbed or deep-ribbed product, the metal sheet, after the corrugating action on the scored sections, travels forwardly to the rib corrugating mechanism, wherein the unscored portions are gradually formed, the depth and width of the corrugations depending upon the width of the unscored portions in the prepared sheets, the shape of the corrugating members and the adjustments in the machine. This gradual folding or shaping of the unscored portions affects the intervening meshwork to partially flatten or spread out the same, *i. e.* a partial folding of the beam members is accompanied by a partial flattening of the meshwork corrugations and vice versa. This flattening out or spreading to completion of the meshwork is accompanied by a corresponding movement of the sides or open edges of the beam members. At this stage of the process all the meshes of the scored sections have been opened and the central portions of the beam members have been folded and shaped leaving the open edges or lower portions of the sides of the beams flaring to meet the meshwork, so as to maintain substantially the same angular relation between the connecting members

or strands of the meshwork and the open edges or lower sides of the beams; also the centers of the scored sections and the centers of the unscored portions have been maintained in equidistant parallel vertical planes. The work, continuing in its forward travel, now passes through the spreading mechanism, wherein the center of the central unscored portion or beam member continues forwardly in its original vertical plane, its closed or top edge continuing preferably in a horizontal plane, while the lower sides of the beam are gradually straightened, and the open edges gradually carried downward. At the same time the same treatment takes place upon the beams adjacent either side of the central member, except in regard to their travel in their respective central vertical planes, which planes of travel are diverted outwardly from the movement of the central member, while preferably the closed or top edges of all the beams continue in the same horizontal plane. Simultaneously with this beam forming and spreading action, the intervening scored sections or meshwork are flattened and the intermediate unscored portions (if any) along the centers of the scored sections may be gradually corrugated longitudinally, this corrugating being effected when it is desired to maintain the angular relation between the connecting members of the meshwork and the outer edges of the intermediate members. The product, as now delivered from the machine is composed of ribbed or longitudinally corrugated beam members connected by intervening meshwork with centrally disposed intermediate members, which may likewise be longitudinally corrugated, the connecting members of the meshwork being arranged edgewise to the general plane of the fabric and with opposed angularity at either side of the unscored members.

The invention will be further understood from a consideration of the drawings and the following detail description.

Figure 1, is a plan view of a fragment of scored material suitably prepared for use in this process. Fig. 2, is a perspective view of a fragment of a preferred form of the finished product. Fig. 3, is a diagrammatical plan view of the work in process, indicating transverse sections at different stages. Fig. 4, is a diagrammatical side view of the same. Fig. 5, is a detail side view of the work in process of corrugation of the scored sections and formation of the meshwork. Fig. 6, is a fragmentary transverse sectional view of the work after the corrugation of the scored sections. Fig. 7, is a side view of the rolls for feeding and corrugating the scored and unscored sections, showing guides for directing the work. Fig. 8, is a plan view of the bottom rolls of the above, showing guides, with certain parts broken away for clearness of illustration. Fig. 9, is a side view of the housing for the foregoing rolls and guides showing adjustments and arrangement of driving mechanism. Fig. 10, is a fragmentary transverse view at 10—10 in Fig. 7, showing guides and bottom feed roll and work diagrammatically therebetween on the plane of the lines 10—10 of Figs. 3 and 4. Fig. 11, is a fragmentary transverse view at 11—11 in Fig. 7, showing the first pair of corrugating rolls, guides and work in process diagrammatically on the plane of the lines 11—11 of Figs. 3 and 4. Fig. 12, is a fragmentary transverse view at 12—12 in Fig. 7 showing the feeding rolls for the intermediate members, guides and work in process diagrammatically. Fig. 13, is a fragmentary transverse view at 13—13 in Fig. 7 showing two pairs of rolls for starting corrugations in the unscored portions on the plane of the lines 13—13 of Figs. 3 and 4. Fig. 14, is a fragmentary transverse view at 14—14 in Fig. 7 showing guides, certain adjustments and work in process diagrammatically. Figs. 15, 16 and 17 represent fragmentary transverse views of pairs of corrugating rolls, at lines 15—15, 16—16 and 17—17 respectively in Fig. 7, for acting consecutively upon the same unscored portion, the work at position of rolls of Fig. 17 being diagrammatically represented at 17—17 in Fig. 3. Fig. 18, is a detailed side view of the mechanism for feeding and spreading the meshwork and completing the formation of the beams. The right hand half shows the outer beam guiding and forming rolls and guides and the means for supporting them. The left hand half shows the rolls and guides for the intermediate ribs or strips and the means for supporting and adjusting them. Fig. 19, is a diagrammatical plan view of the feeding and spreading mechanism, showing location of the main feeding rolls and certain individual spreading and forming rolls. Figs. 18 and 19 are on a slightly smaller scale than Figs. 7 to 17. Fig. 20, is a cross sectional view of the spreader bars and rolls at 20—20 in Figs. 18 and 19 and showing the work in process. Fig. 21, is a cross sectional view of the spreader bars and rolls at 21—21 in Figs. 18 and 19. Fig. 22, is a fragmentary plan view of two adjacent spreader bars and rolls, one for a deeply corrugated member and one for its adjacent intermediate member. Fig. 23, is a fragmentary side view partly in vertical section showing the vertical end adjusting means, such as controls all intermediate spreader bars. Fig. 24, is a fragmentary transverse view on the line 24—24 in Fig. 23 showing an arched support, with a part broken away to show the transverse adjusting means, for upper spreader bars and also showing the end of one intermediate spreader bar, with its adjusting yoke in po-

sition shown in section. Fig. 25, is a fragmentary transverse section showing a modification of rolls for treating a reversely directed beam. Fig. 26, shows a fragment of this fabric completed as in my Patent #1,104,476 dated July 21st, 1914. Fig. 27, is a transverse vertical sectional view showing means for indenting or corrugating the sides of a beam member, as shown in my application #693,329 filed April 26th, 1912. Fig. 28, is a side view of a modified form of corrugating mechanism designed more particularly for opening the mesh of scored material, in which the unscored portions are relatively narrow. Fig. 29, is a fragmentary transverse sectional view on line 29—29 in Fig. 28 showing portions of the corrugating rolls and the character of fabric, for which this machine is particularly adapted.

The preferred form of mechanism herein shown and described is for forming a fabric such as illustrated in Fig. 2. The blank from which the fabric is made is shown in Fig. 1. Sections 30 of the sheet are first scored or slitted by suitable mechanism leaving unscored members, portions or strips 31 at the margins and one or more intermediate portions of the sheet. Each section is preferably made up of two parts 32, 32. As shown the scoring is along lines inclined or diagonal relative to the length of the sheet so as to form bendable strands or connecting members 33, 33, adjacent strands being connected to each other at a plurality of points or bonds 34, 34, 34. The strands in the two parts of the scored section preferably are inclined in opposite directions. The inclination is such that the strands diverge from the center of the scored section forwardly in the direction in which the stock is fed through the corrugating and spreading machine. Preferably an unscored strip or member 35 is left between the two scored parts 32, 32, along the center of each of the scored sections 30.

The corrugating action opens the scored sections into meshwork 36, 36 with channels or troughs 37, 37 between them and spaces 38, 38 on each side. The subsequent treatment folds or corrugates the unscored members 31, 31 into deep rib-like beams 39, 39. The meshwork sections are flattened into a common plane as shown in Fig. 2 and the intermediate unscored strip or member 35 is preferably longitudinally corrugated or folded along its central line into a channel-like rib or member 40, the edges of which face in the opposite direction to the edges of the beam members 39. A suitable introductory table and gages are provided at 40′ so as to enter the stock properly into the machine.

Throughout the machine, the margins and interior unscored members 31 are each acted upon by a series or train of rolls or disks which serve to feed the sheet forwardly and corrugate the unscored members and spread them apart so as to flatten the meshwork sections into a common plane. As each train or series of rolls or disks for acting upon the broad unscored members is exactly like each of the others, it will only be necessary to describe one series in detail. Similarly each series or train of rolls or disks for acting upon unscored strips 35 intermediate the broad unscored members is like each of the others, and it will be necessary therefore to describe only one of these.

In Figs 3 and 8 I have shown a diagram of the method and rolls for forming a 3-rib fabric, while in Fig. 19 I have indicated diagrammatically the treatment of an additional rib at each edge of the fabric. In Fig. 19 the shafts of the upper rolls 53, 63 and 73 are shown broken away to disclose the lower rolls 54, 64, and 74 and parts of their shafts. The rolls 56, 58, 72, 90 and 92 belong to the lower trains of rolls in Fig. 18 and the rolls 55, 57, 59, 61, 65, 67, 69, 71, 89, 91 and 92 belong to the upper train of rolls.

The train of rolls or disks for acting upon one of the marginal unscored members is indicated in side view in Figs. 7 and 18 and in plan view in Figs. 8 and 19. Rolls 41 and 42 feed the broad unscored member 31 forwardly. Rolls 43 and 44 are part of the corrugating set which open the scored sections to form the meshwork. Rolls 45 and 46 start the corrugating or folding of the unscored members. The pairs of rolls 47 and 48; 49 and 50; 51 and 52 substantially complete the folding of the center of the unscored members into the deep ribs or beams with flaring edges or bases (see sections 17—17 Fig. 3). Rolls 53 and 54 serve to feed the beams forwardly. The centers of all the rolls of the trains thus far mentioned are in parallel vertical planes equidistant apart. Passes between the rolls of a train are arranged so as to maintain a central portion of each beam member in substantially the same horizontal plane as the passes between the rolls 43 and 44. In Fig. 18 the left half of the outer set of rib-forming and directing rolls is removed but one of the inner set is shown. Rolls 55 and 56; 57 and 58; 59 and 60, 61 and its corresponding lower roll (not shown) on shaft 62, serve to direct the outer rib or beam outwardly to the feed rolls 63 and 64. Similarly rolls 65 and 66; 67 and 68; 69 and 70; 71 and 72 continue the diverging or spreading action up to the final passes of the finishing delivery rolls 73 and 74.

Downwardly inclined guides 75 and 76 lead the unscored members from the feed rolls 41 and 42 to the corrugating rolls 43. Guides 77 and 78 extend between the rolls 43 and 44 and 45 and 46. A guide 79 di-

rects the partially formed rib or beam from the rolls 45 and 46 to the rolls 47 and 48. Similar guides are arranged between the succeeding rolls. Appropriately formed guides such as 80 extend between adjacent rolls of each train in the spreading part of the machine (Fig. 18).

Each intermediate strip along the center of each of the scored sections is acted upon by a series of guides and rolls. The guide 83 extends downwardly from between the rolls 41 to direct the scored section to the guide 84 between the rolls 43. The rolls or disks 85 and 86 serve to feed the intermediate strip forwardly. An inclined guide 88 is arranged beneath the intermediate strip and extends substantially to the shaft of the feeding rolls 53 previously mentioned. From here on each intermediate strip is acted upon by a train of rolls such as 89 and 90 and 91 and 92. These trains of rolls are arranged along lines whose vertical planes gradually diverge to the delivery end of the machine and the passes between the rolls are arranged on gradually inclined downward lines so that the fabric as it emerges from the machine has all the mesh work and the intermediate ribbed strips in substantially the same plane with the lower edges of the deep ribs or beams. Guides such as 93 are arranged between the adjacent lower rolls 90 and similarly (not shown) between adjacent lower rolls 92. A similar but longer guide 94 extends from the last roll of the series 90 to the first roll of the series 92 extending between the shafts of the feed rolls 63 and 64.

It will be obvious that the bearing faces of the guides 84 and 88 might be provided with rollers if desired to reduce the friction and facilitate the movement of the stock through the machine.

Suitable housings are provided for supporting the various parts as for instance as indicated in Figs. 9 and 18.

It is desirable that the machine be able to handle stock of different gages and of different widths of strands and also to produce different degrees of expansion. Certain of the parts are therefore made adjustable for varying the gripping pressure in the stock and also for varying the corrugating and spreading actions. The shafts of the upper rolls 41, 43, 45, 47, 49, 51, 53, 63 and 73 are provided with vertically sliding boxes such as 100 with ordinary pressure and lifting screws 101 and check nuts 102, (see Fig. 9).

The shafts of the lower rolls 42 are provided with horizontally sliding boxes 104 with suitable screws and check nuts. The upper guides 75 and 83 are preferably secured together and secured in slots 105 in the housings for instance by bolts 106, 106. The horizontal adjustment of the rolls 42 and guides 75 and 83 will effect a change in the angle of approach of the stock to the corrugating rolls and guides and thus direct the stock at that angle which will avoid buckling. By arching the guides 83 slightly, allowance is made for corresponding arching of the scored sections. The guide 84 has a lug 107 secured in the inclined slot 108 by bolts 109. By adjusting the guides 84 upward and toward the right (Fig. 7) an increased corrugating effect may be accomplished on the scored sections. The guide 76 may be made adjustable on the guide 84 in a similar manner. The flange 76′ of the guide 76 approaches the outer lower roll 44 so as to assist in directing the scored and unscored sections. The guides 77 and 78 are carried by cross bars 110 and 111 respectively which extend across between the main housings. The shafts of the rolls 85 and 86 are provided with vertically adjustable sliding boxes 112 and 113, so that these rolls may be vertically adjusted to correspond with the corrugations produced by the previous guides and rolls.

The guides 79 are supported by cross bars such as 114, which extend between the side housings. The guides or tracks 88 are supported by these cross bars 114 and vertically adjustable for instance, by bolts 115 so that they may be brought to a proper height to correspond with the upper edge of the guide 84 and the gripping pass of the rolls 85 and 86. The cross pieces 114 are made vertically adjustable for the purpose of raising or lowering the guides 79 and 88. This vertical adjustment may be accomplished by having a bolt and slot connection 114′ with the housing.

For convenience in construction, adjustment, operation, etc. the spreading machine is made up of two parts the details of which are substantially identical (see Figs. 18 and 20 to 24). The lower rib rolls 56, 58, 60 and 62 and guides 80 of one train are all carried by a lower bar 120 and the lower rolls 66, 68, 70 and 72 and guides 80 for the same rib or beam are carried by a similar bar 121. These two bars are alike but reversed end for end. All of the bars 120 are mounted on cross pieces 122 so that they can be adjusted laterally to vary the spreading action and the cross pieces are vertically adjustable at 123 in the housings. Bars 121 are similarly mounted. The lower rolls and guides for the other deep ribs or beams are mounted in the same manner. The upper grooved rolls 55, 57, 59 and 61 of a set for one rib, are carried by a bar 125. The corresponding bars carrying the rolls for the different deep ribs of the same sections are supported from cross pieces 126 and 127 by means of bolts such as 128 which pass through slots 129 in the cross pieces so as to permit lateral adjustment. The rolls 65,

67, 69 and 71 are carried by a bar 130 which is like bar 125 but reversed end for end and supported in a similar manner.

The rolls and guides for the intermediate strips 35 are carried by bars of the same general character so as to permit vertical and lateral adjustment. The lower rolls 90 and guides 93 of a given train are carried by a bar 132. Each end of each bar 132 is supported in a yoke such as 133 and the adjacent yokes are mounted on a cross piece 134 between the housings so that the bars may be vertically adjusted in the yokes and the yokes may be laterally adjusted between the housings. The construction and operation will be better understood in connection with the support for the upper intermediate roll carrying bars. The rolls 92 and intervening guides (not shown but similar to 93) are carried by a bar 136 similar to 132 but reversed end for end and supported in a similar manner. The rolls 89 of a train are carried by a bar 138 supported at its opposite ends in yokes such as 139. Adjacent yokes are suspended from the cross piece 126, for instance by bolts 140 (Fig. 23). Each bolt passes through a slot 141 in the cross piece 126 so as to permit of lateral adjustment. Each yoke is slotted or forked at 142 to accommodate the end of the bar 138 and permit its vertical adjustment. The two ends of each bar may be adjusted to the same degree or differently as the occasion may require. Provision is therefore made for changing the angle of inclination of the bar 138. The bolt 140 presses against the upper edge of the bar 138. Bolts 143 pass freely through slots 144 in the cross piece 126 and through the yoke and through the holes 145 and are screwed into rotatable bushings 146 in the end of the bar. By loosening on bolts 143 the end of the bar may be lowered. By loosening the bolts 140 and tightening the bolts 143 the end of the bar may be raised. The enlarged hole 145 and rotatable bushing 146 permits the tilting of the end of the bar without bending or cramping the bolt. The center yoke 139 accommodates the adjacent abutting ends of the front and rear bars and thus keeps them in approximate alinement. By adjusting the upper or lower set of intermediate rolls relative to the other set, the stock may be gripped more or less as occasion may require.

It will be obvious that the various disks or rolls may be integral with their shafts or made separately and secured in the usual method of gears, pulleys, etc. so that they may be removed or adjusted or replaced. The action from start to finish being entirely a natural continuous rolling operation, the work may be fed by driving all or part of the rolls. I prefer to apply most of the driving power to the broad unscored portions and the more rigid deep ribs or beams at suitable intervals to keep the product moving through the machine. I also prefer to apply a driving force to the intermediate unscored strips in order to preserve the proper relation with the deep ribs or beams and the intervening meshwork.

After the meshwork is formed as shown in Fig. 5 all parts of the fabric travel forward at substantially the same speed.

It will be obvious that different systems of drive may be employed such as spur or bevel gears, chains or belts. I have illustrated a system employing spur gears in part and chains in part. Both of these have special advantages in special cases. The gears and chains are represented simply by means of dot and dash lines indicating their pitch lines. In the method of drive illustrated, power is intended to be applied to the shaft 150 and transmitted to the gear wheel 151 on shaft 52′ of the lower deep rib-forming rolls 52. Power is transmitted from this shaft through the gears 152, 153, 154, 155, 156, 157, 158, sprocket 159, chain 160, sprockets 161, 162 and 163, chain 164 and sprocket 165. Gears 154, 156 and 158 are on the respective shafts of the rolls 50, 48 and 46. Gears 153, 155 and 157 are idlers. Sprocket 159 is on the shaft with gear 158. Sprocket 161 is on the shaft with roll 86. Sprockets 162 and 163 are on the shaft with roll 44. Sprocket 165 is on the shaft with roll 42. As the roll 86 and its sliding box 113 is vertically adjustable I have provided a take-up or adjustable idle roll or sprocket 166 for the chain 160. Similarly as the roll 42 and its sliding box 104 is horizontally adjustable, I have provided an adjustable roll or take-up sprocket 167. It is obvious that the upper rolls will normally rotate with the travel of the stock but any of these that may be desired may be positively driven. Rolls of the spreading mechanism are driven by chains from the sprocket 170 on shaft 52′. Chain 171 drives sprocket 172. A companion sprocket drives chain 173 and sprocket 174. A companion of the sprocket 174 drives chain 175 and sprocket 176 which is on the shaft of the rib-feeding rolls 54. As the ribs or beams from this point diverge outwardly in the spreading action, I have shown simple bearing disks or rolls 53 for engaging the tops of the ribs instead of grooved rolls. The smooth rolls permit the ribs to diverge without wedging or binding between the rolls. A companion of sprocket 172 drives chain 177 and sprocket 178. A companion to sprocket 178 drives chain 179 and a sprocket of the same diameter on the shaft of roll 64. These rolls 64 and the rolls 63 engage the deep ribs or beams to feed them forwardly. The lower rolls 64 engage within the inverted channels of the beams while the upper rolls 63 are left smooth to engage the upper edges

of the ribs and effect the forward feed without binding on the ribs which are still diverging at this point. A companion of sprocket 178 drives chain 180 and sprocket 181. A companion to sprocket 181 drives chain 182 and sprocket 183. A companion to sprocket 183 drives chain 184 and sprocket 185 on the shaft of the lower finishing and delivery rolls 74. These rolls 73 and 74 serve to give a final finish to the deep ribs or beams and eject the finished product from the machine. It will be obvious that the fabric may be passed subsequently through a train of straightening rolls if desired either in the same or separate machine.

As before mentioned, I also prefer to exert a feeding tension on the intermediate strips 35. This is accomplished by driving the bottom rolls 90 and 92 by means of chains such as indicated at 190 on sprockets such as 191 (see Figs. 21 and 22). The left hand roll 90 of each of the bars 132 (Fig. 18) is driven by a chain 192 from a sprocket 193 on the intermediate shaft 194 which also carries the sprocket 174. Power is thus applied from the shaft 194 to the first roll of each train of rolls 90 and thence along to the other rolls in that train. The rolls for the other intermediate strips are driven in a similar manner by chains from shaft 194. The chains being flexible permit the bars 132 to be adjusted angularly to accomplish different spreading actions. The train of lower rolls 92 is driven in a similar manner from the front end from the intermediate shaft 195 and chain 196. The chain 190 passes around the sprockets 191 on the same side of adjacent rolls 90, its upper part passing along the edge of the bar 132 beside the guide 93 and its lower part passing from the recess 197 along the lateral channel 198 in the side of the bar. It will be obvious that the top rolls 89 and 91 might be driven in a similar manner.

When desired to form a deep ribbed product with the reverse channels at either side of the beam members as shown in my Patent #1,104,476 dated July 21, 1914, the corrugations may be formed with their apices downward as shown in Fig. 25 instead of upward and their outer flanges 200 may be gradually turned downward and inward toward the sides of the beams as shown in Fig. 26 in order to maintain the proper relation between the edges of the beams and the connecting members of the meshwork.

In Fig. 27 I have illustrated means for indenting or grooving the sides of the beam members for the purpose of forming lateral recesses or longitudinal channels and shoulders and thus improving the capacity of the beam members for bonding in the concrete or cement. The beam member 202 is supported on a guide or disk 203 so as to leave the upper edge of the beam member standing some little distance above the edge of the guide. The upper edge is held in place by a guide or roll 204 while the sides are indented or grooved by rolls 205 which press the sides of the beam member together beneath the upper edge as the beam moves between the rolls 205. By making the edges of the rolls 205 smooth, a continuous longitudinal channel may be produced. If the edges of the rolls are roughened or provided with spaced projections or teeth, the sides of the beams will be correspondingly formed. These rolls or other devices may also be arranged to perforate the sides of the beams if desired.

Figs. 28 and 29 show a modification of the corrugating mechanism for opening the scored stock. In this case all of the unscored strips or portions of the stock to be treated are relatively narrow. As the corrugating action in this case moves the center of each scored section downward relative to the margins of the sheet, the scored stock should be fed in a direction opposite to the feed of the stock in the process as outlined on sheet one. The table and gages 210 lead the scored stock to the rolls 211 and 212. The disks 213 are spaced apart axially a distance equal to the width of a scored section. Bands such as 214 pass around the roll 211 and the disks 213. The outer bands should be a little wider to grip the marginal unscored strips. A ring 215 is pressed against the band 214 between the roll 211 and the disk 213 by means of suitable yoke-carried adjustable pressure rolls 216, 216, so as to grip the marginal and alternate inner unscored strips 217. Disks 218 alternate with the rings 215 and are connected with the roll 212 by bands such as 219, which serve to carry the intermediate unscored strips 220 relatively downward. The stock is directed away from the corrugating mechanism on guides 221 leading to suitable spreading mechanism, for bringing all the meshwork into a common plane. The bands 214 and 219 respectively may be kept taut by adjustable take-up rolls or idlers 222 and 223.

It will be obvious that other modifications may be made in various parts of the mechanism. Although it is preferred to complete the corrugating and spreading action in a continuous operation it will be obvious that many of the advantages may be obtained even if the mechanism is not arranged to permit a continuous action.

What I claim is:—

1. In an expanded metal machine, a plurality of spaced pairs of disks for engaging the longitudinal marginal and interior unscored strips of a sheet having interior sections scored between the unscored strips, curved guide members extending between the spaced disks for carrying the centers of the scored sections out of the plane of the

unscored strips and means for guiding the sheet tangentially to said disks and to said curved guides.

2. In an expanded metal machine, a plurality of spaced pairs of disks for engaging the longitudinal marginal and interior unscored strips of a sheet having interior sections scored between the unscored strips, curved guide members extending between the spaced disks for carrying the centers of the scored sections out of the plane of the unscored strips, means for guiding the sheet to said disks and to said curved guides and guards between the edges of the outer disks and the adjacent guides.

3. In a machine of the character described means for corrugating the longitudinal scored portions of a partially scored sheet to form meshwork, rolls for gradually corrugating longitudinal unscored portions of said sheet to form beams, diverging trains of rolls for spreading the beams and inclined diverging trains of rolls for corrugating intermediate unscored strips as the sheet moves forward.

4. In a machine of the character described, means for feeding a sheet consisting of alternate longitudinal scored sections and unscored strips, means for corrugating the scored sheet to open the scored sections and form meshwork, means for gradually corrugating the centers of alternate unscored strips to form beams leaving the edges flaring and means for subsequently gradually flattening out the meshwork and simultaneously bending the edges of the beams.

5. In a machine of the character described, means for feeding a sheet consisting of alternate longitudinal scored sections and unscored strips, means for corrugating the scored sheet to open the scored sections and form meshwork, means for gradually corrugating the centers of alternate unscored strips to form beams leaving the edges flaring, means for gradually flattening out the meshwork and simultaneously bending the edges of the beams, and means for corrugating the intermediate strips at the same time that the edges of the beams are bent.

6. In a machine of the character described, means for feeding a sheet consisting of alternate longitudinal scored sections and unscored strips, means for corrugating the scored sections to form meshwork, means for gradually corrugating the centers of alternate unscored strips to form beams leaving the edges flaring laterally and means for spreading the beams and bringing the meshwork into a common plane.

7. In a metal working machine, rolls for feeding scored stock in one plane, a guide extending from one roll for directing the scored stock around one face of the other feed roll, pairs of spaced feed rolls providing passes in a different plane from the first feed rolls and guide bars extending between some of said latter rolls in a plane between the planes of the passes of the two sets of feed rolls.

8. In a metal working machine, rolls for feeding scored stock in one plane, a guide extending from one roll for directing the scored stock around one face of the other feed roll, pairs of spaced feed rolls providing passes in a different plane from the first feed rolls, guide bars extending between some of said latter rolls in a plane between the planes of the passes of the two sets of feed rolls and other feed rolls having passes in line with the bearing faces of said guide bars.

9. In a machine of the character described, a plurality of rotary spaced disks each coacting with the face of a longitudinal strip at one face of a scored sheet, inclined guides leading to said disks, a guide bar extending between each two adjacent disks for the faces of an intermediate strip at the opposite face of the sheet and means for holding the longitudinal strips against said disks and means for feeding the scored sheet to the said guides and the guide bars.

10. In a machine of the character described, spaced curved members, inclined rear guides leading thereto and front guides leading therefrom, guide bars extending between said curved members with bearing faces in a plane spaced apart from the plane of said front guides and means for drawing a sheet having alternate scored and unscored sections between said guides and bars and around said curved members.

11. In a machine of the character described, means for feeding and corrugating a sheet scored only in longitudinal sections to form inclined meshwork sections connected and bordered by unscored strips, the marginal and alternate strips lying in one plane and the intervening strips lying in another plane, means for feeding the strips in one plane and means in another plane for feeding the strips in the other plane.

12. In a machine of the character described, corrugating means for opening stock scored only in longitudinal sections, comprising rotary spaced disks, a rotating member coacting therewith, guide bars extending between said disks, and inclined guides leading to said bars and to said disks.

13. In a machine of the character described, feed rolls, an inclined curved guide leading therefrom and two sets of spaced members extending therefrom, one set being in one plane for longitudinal unscored portions of a sheet and the other set being in another plane for engaging the longitudinal scored portions and corrugating the sheet.

14. In a machine of the character described, feed rolls, a set of spaced disks, in-

clined curved guides between said feed rolls and said disks and a guide extending between each two adjacent disks for corrugating a stock consisting of longitudinal scored and unscored portions.

15. In a machine of the character described, spaced disks, a bar extending between each two adjacent disks and having a guide surface in a plane parallel to but spaced apart from the plane of the working surfaces of said disks and means for directing a sheet of metal consisting of longitudinal scored and unscored sections toward said disks tangentially so that the unscored sections pass around the working surfaces of said disks and said scored sections engage said bars whereby the strands of the scored sections are uniformly bent and the meshwork gradually formed.

16. In a machine of the character described, feed rolls, corrugating means adjacent thereto and including spaced curved members, intermediate guide bars and inclined connecting guides and means for adjusting one of said feed rolls toward and from said curved members.

17. In a machine of the character described, feed rolls, spaced curved holding members, holding means coöperating therewith, guide bars between said curved members, inclined guides between said feed rolls and said curved members and means for adjusting said guides relative to said bars.

18. In a machine of the character described, spaced curved members, holding means coöperating therewith, guide bars between said members having curved introductory portions inclined leading thereto and means for adjusting the curved introductory portions relative to said curved members.

19. In a machine of the character described, spaced corrugating rolls for engaging longitudinal unscored portions of partially scored stock, means for feeding stock thereto holding means coöperating with said rolls, guide bars extending between said rolls for supporting intermediate unscored strips and means for adjusting said bars toward and from the axis of said rolls.

20. In a machine of the character described, spaced corrugating rolls for engaging longitudinal unscored portions of partially scored stock, means for feeding stock thereto holding means coöperating with said rolls, guide bars extending between said rolls for supporting intermediate unscored strips, means for adjusting said bars toward and from the axis of said rolls, and adjustable means for feeding the strips along said bars.

21. In a machine of the character described, means in one plane for gradually corrugating the centers of unscored strips to form beams with flaring edges, and means in a plane substantially parallel with, but spaced apart from the first mentioned plane for feeding intermediate unscored strips of a corrugated meshwork.

22. In a machine of the character described, means for guiding a sheet consisting of unscored strips connected by meshwork sections inclined relative thereto and means for gradually folding the centers of said strips and flaring their edges outwardly so as to maintain the edges at substantially the same angle relative to the inclined sections of meshwork as the fabric moves through the machine.

23. In a machine of the character described, a plurality of series of pairs of spaced grooving rolls with passes arranged in one general plane and a series of pairs of grooving rolls arranged between each two adjacent series of the first mentioned pairs of rolls and with their passes in a general plane spaced apart from the plane of the passes of the first mentioned pairs at the entrance end, the edges of all the passes of all the rolls being in substantially the same plane at the exit end of the machine, all the lateral series of rolls diverging gradually outward for spreading and flattening the sheet.

24. In a machine of the character described, a plurality of series of pairs of grooving rolls formed and arranged to gradually fold the unscored strips, guides arranged between adjacent series of pairs of rolls for supporting the centers of the meshwork sections and feeding means engaging the stock on said guides.

25. In a machine of the character described, a plurality of series of pairs of grooving rolls, the successive pairs of each series having passes for gradually folding an unscored strip of a fabric consisting of unscored strips and open meshwork arranged in channel form between the strips and narrow supporting guides for the meshwork between its sides arranged between adjacent series of pairs of grooving rolls and slightly decreasing gradually in height to permit a slight spreading of the meshwork as the strips are gradually folded.

26. In a machine of the character described, a plurality of series of pairs of grooving rolls, the successive pairs of each series having passes for gradually folding an unscored strip of a fabric consisting of unscored strips and open meshwork arranged in channel form between the strips and guides for the meshwork arranged between adjacent series of pairs of grooving rolls and decreasing gradually in height to permit the spreading of the meshwork as the strips are gradually folded and means for grooving the stock along said guides.

27. In a machine of the character described, diverging trains of rolls for acting upon the previously formed grooved beams

and intermediate diverging trains of rolls for corrugating the unscored portions intermediate the beams during their uniformly downward travel to the plane of the finished product.

28. In a machine of the character described, the combination of means for feeding a sheet having alternate longitudinal scored sections and unscored strips, means for directing marginal and interior unscored strips into one plane and the alternate unscored strips into another plane separated from but parallel to the first mentioned plane and thus opening the scored sections, means for gradually forming alternate unscored strips into channel-like beams, diverging means for spreading the beams and guiding means for directing the meshwork as it is drawn into a common plane by the spreading of the beams.

29. In a machine of the character described, the combination of means for feeding a sheet having alternate longitudinal scored sections and unscored strips, means for directing marginal and interior unscored strips into one plane and the alternate unscored strips into another plane separated from but parallel to the first mentioned plane and thus opening the scored sections and corrugating rolls engaging all of said unscored strips for folding alternate unscored strips in opposite directions.

30. In an expanded metal machine, a plurality of trains of pairs of rolls for progressively bending the edges of longitudinal unscored strips of a sheet scored only between longitudinal unscored strips, and trains of pairs of rolls alternating with the first mentioned trains of rolls for bending unscored strips of said sheet between the first mentioned unscored strips and in the opposite direction, the planes of the edges of the passes of the two said sets of trains of rolls being spaced apart at the entrance end of the machine and being substantially coincident at the exit end.

31. In a machine of the character described, a series of trains of devices for gradually folding unscored strips of a corrugated meshwork, and feeding rolls for engaging other unscored strips of said corrugated meshwork between the trains of folding devices and in a plane spaced apart from the folding strips.

32. In a machine of the character described, a series of trains of devices for gradually folding unscored strips of a corrugated meshwork, narrow guides extending between the trains of folding devices and projecting above the plane of the operative faces of said devices for supporting and guiding other unscored strips of said corrugated meshwork.

33. In a machine of the character described, a series of trains of devices for gradually folding unscored strips of a corrugated meshwork, narrow guides extending between the trains of folding devices and projecting above the plane of the operative faces of said devices, and means for vertically adjusting said guides.

34. In a machine of the character described, a series of trains of devices for gradually folding unscored strips of a corrugated meshwork, feeding rolls for engaging other unscored strips of said corrugated meshwork between the trains of folding devices and in a plane spaced apart from the folding strips and means for vertically adjusting both of said rolls.

35. In an expanded metal machine, a plurality of pairs of laterally adjustable bars diverging from the entrance toward the exit end of the machine, upper and lower coacting guide members carried by each pair of bars, the guiding surfaces of alternate pairs of bars being arranged to guide longitudinal members of a corrugated meshwork stock in one plane and the guiding surfaces of intermediate pairs of bars being arranged inclined to guide intermediate portions of the stock from a plane parallel to the first mentioned plane on a gradual incline toward the first mentioned plane, said intermediate bars being vertically adjustable for varying the inclination.

36. In an expanded metal machine, a plurality of longitudinally extending laterally diverging bars, a series of beam guiding rolls rotatably supported by each bar, the plane of rotation of the rolls carried by each bar being parallel to the length of said bar, relatively stationary guides carried by each bar between the rolls of said bar and means for holding beams on said rolls and guides as the stock is spread in passing through the machine.

37. In an expanded metal machine, a plurality of longitudinally extending laterally diverging bars, guiding devices carried by alternate bars for guiding longitudinal beams of meshwork stock in a horizontal plane, guiding devices carried by the intermediate bars for guiding intermediate longitudinal strips of said stock at an inclination to said beams, a transverse supporting member at each end of said bars, yokes transversely adjustable on said members, and means of connection between said yokes and said bars for supporting said bars, the intermediate bars being vertically adjustable in their yokes for varying the inclination of said bars.

38. In a machine of the character described, a supporting yoke, a bar having a transverse recess, a bushing oscillable in said recess, a screw engaging in said bushing to draw said bar toward said yoke and a screw for forcing said bar away from said yoke.

39. In an expanded metal machine, a

series of laterally separated trains of lower and upper rolls for gradually forming beams by bending downward the edges of unslitted strips of stock consisting of unslitted strips and intervening meshwork sections, the lower rolls having projecting ribs for supporting the centers of the respective unslitted strips and the upper rolls being grooved to receive the ribs of the lower rolls, the said upper and lower rolls being so shaped and placed as to leave the edges of the unslitted strips relatively free while the principal pressure is applied along the centers of the strips being formed.

40. In an expanded metal machine, a plurality of trains of devices for gradually forming grooved beams from unslitted strips of a stock consisting of longitudinal unslitted strips and oppositely inclined meshwork sections connecting adjacent unslitted strips and longitudinally extending devices arranged to guide the meshwork sections between said beam forming devices while the beams are being formed.

41. In a machine of the character described, an angularly adjustable bar, a train of rolls carried thereby, a chain for transmitting power to the first roll of the train and chains for transmitting power from roll to roll in the train.

42. In a machine of the character described, a bar, thin strip-supporting rolls carried thereby for extending up between the inclined sides of meshwork, means for driving the first roll and chains extending along the edges of the bar for transmitting power from roll to roll.

43. In a machine of the character described, a series of diverging trains of beam-spreading rolls and a series of inclined, diverging trains of strip-engaging rolls between the beam spreading rolls independently supported.

44. In a machine of the character described, a series of diverging trains of beam-spreading rolls and a series of inclined, diverging trains of strip-engaging rolls arranged in staggered relation thereto.

45. In a machine of the character described, a series of diverging trains of ribbed spreading guides and rolls adapted to extend up into the channels of grooved beam members and to support the same while spreading, trains of grooved rolls engaging the tops of the beams on said spreading members and feeding rolls respectively engaging the tops of the outsides of the beams and the tops of the insides of the beams leaving the sides free to move at an angle to the direction of force applied.

46. In a machine of the character described, a series of trains of ribbed diverging spreading rolls for supporting the interior of grooved beams, grooved rolls above the ribbed rolls for engaging the tops and outsides of the beams, rolls for feeding the grooved beams onto said ribbed spreading rolls, rolls for feeding the beams off of the spreading rolls and intermediate feeding rolls for keeping the beams moving through the trains of spreading rolls.

47. In a machine of the character described, a series of trains of ribbed diverging spreading rolls for supporting the interior of grooved beams of a fabric, grooved rolls above the ribbed rolls for engaging the tops and outsides of the beams, rolls for feeding the grooved beams onto said ribbed spreading rolls, rolls for feeding the beams off of the spreading rolls, intermediate feeding rolls for keeping the beams moving through the trains of spreading rolls and means arranged between the trains of ribbed rolls for feeding intermediate unscored strips of said fabric.

48. In a machine of the character described, a series of trains of laterally adjustable diverging strip-engaging and spreading devices, and trains of vertically and laterally adjustable inclined diverging strip-engaging spreading devices arranged between the first mentioned spreading devices for gradually spreading a corrugated meshwork and bringing alternate unscored strips and all the meshwork into a common plane.

49. In a machine of the character described, a series of trains of laterally adjustable diverging strip-engaging and spreading devices, trains of vertically and laterally adjustable inclined diverging strip-engaging spreading devices arranged between the first mentioned spreading devices for gradually spreading a corrugated meshwork and bringing alternate unscored strips and all the meshwork into a common plane, each of said series of trains including rolls and means for driving said rolls so as to feed all of the unscored strips of the fabric.

50. In a machine of the character described, guides for supporting unscored strips of a fabric in one plane between oppositely inclined meshwork sections of said fabric, means alongside of said guides for corrugating other alternate unscored strips of said fabric in a lower plane for forming beams and stretching the meshwork sections over the guides.

51. In a machine of the character described, guides for supporting unscored strips of a fabric between oppositely inclined meshwork sections of said fabric, means alternating with said guides for corrugating other unscored strips of said fabric in a lower plane for forming beams and means for corrugating the first mentioned strips.

52. In a machine of the character described, guides for supporting unscored strips of a fabric between oppositely inclined

meshwork sections of said fabric, means adjacent said guides for corrugating other unscored strips of said fabric in a lower plane for forming beams and means for afterward spreading the beams and thus bringing the intervening strips and meshwork into a common plane.

53. In a machine of the character described, corrugating means for carrying unscored strips of a partially scored sheet into separated parallel planes and thus opening the intervening scored sections of the sheet into meshwork, means for then corrugating alternate unscored sections of said sheet to form beams and means for subsequently spreading the beams and bringing the intervening unscored strips of said sheet and the meshwork sections into the plane of the bases of the beams.

54. In an expanded metal machine, a series of trains of rolls arranged on diverging lines for guiding and spreading grooved beams of a meshwork stock and upper and lower diverging inclined sets of devices arranged between the trains of spreading rolls for guiding intermediate unslitted strips of the stock and preventing said strips from turning edgewise as the stock is spread.

55. In an expanded metal machine, a series of trains of rolls arranged on diverging lines for guiding and spreading grooved beams of a meshwork stock and inclined diverging guides arranged alternating with said trains of rolls for guiding unslitted strips of the stock between the beams as the strips are gradually drawn into the plane of the bases of the beams by the spreading of the beams.

56. In an expanded metal machine, a series of diverging trains of interfitting upper and lower rolls for guiding the beams of meshwork stock and spreading the stock laterally, the plane of rotation of the rolls of each train of rolls being parallel to the direction of its train whereby the gripping surfaces of the rolls move in the direction of travel of the diverging beams guided thereby.

NORRIS ELMORE CLARK.

Witnesses:
ROBT. S. ALLYN,
J. GILMAN.