

June 25, 1935.

R. J. MILLER

2,006,087

APPARATUS FOR WORKING SHEET METAL

Filed May 3, 1930

5 Sheets-Sheet 1

Fig. 1.

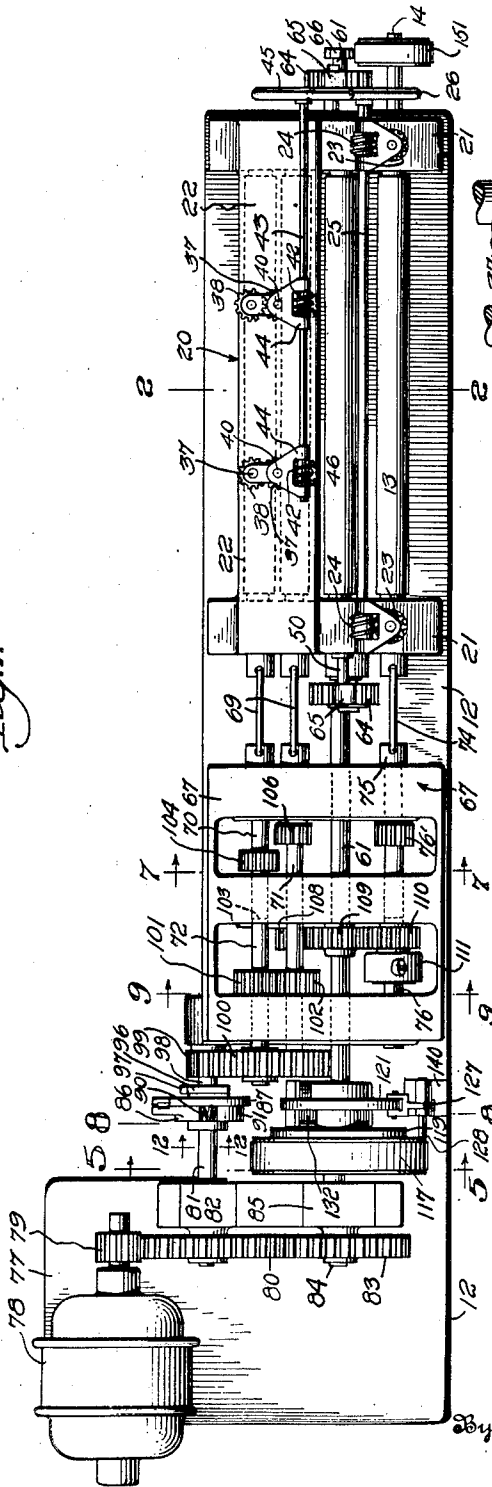


Fig. 3.

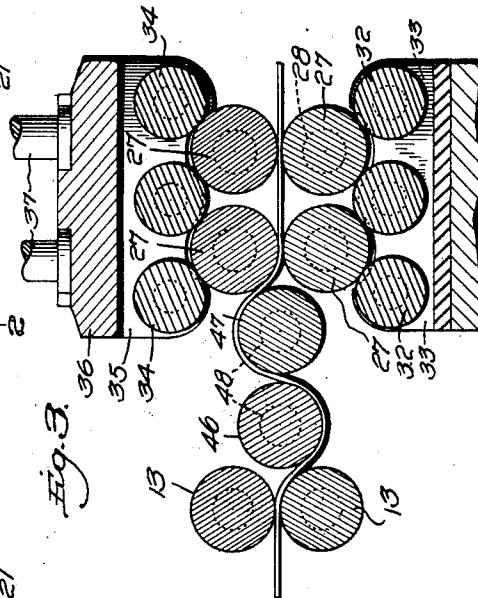
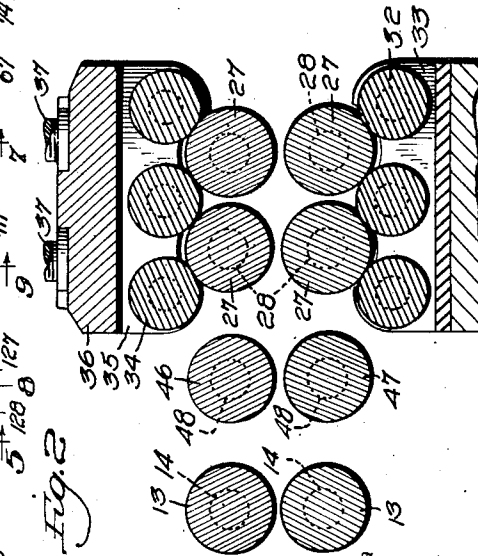


Fig. 2.



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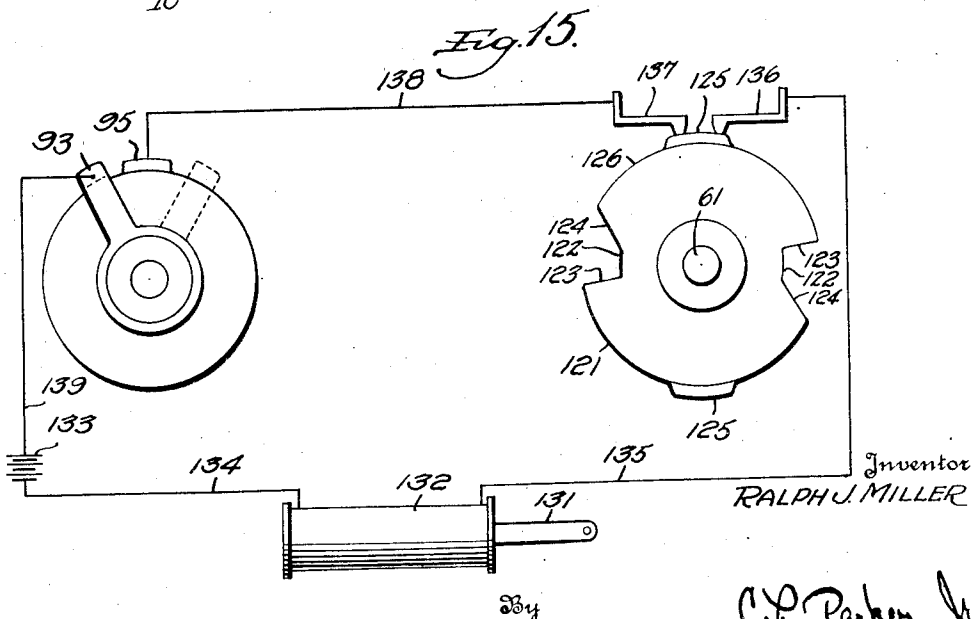
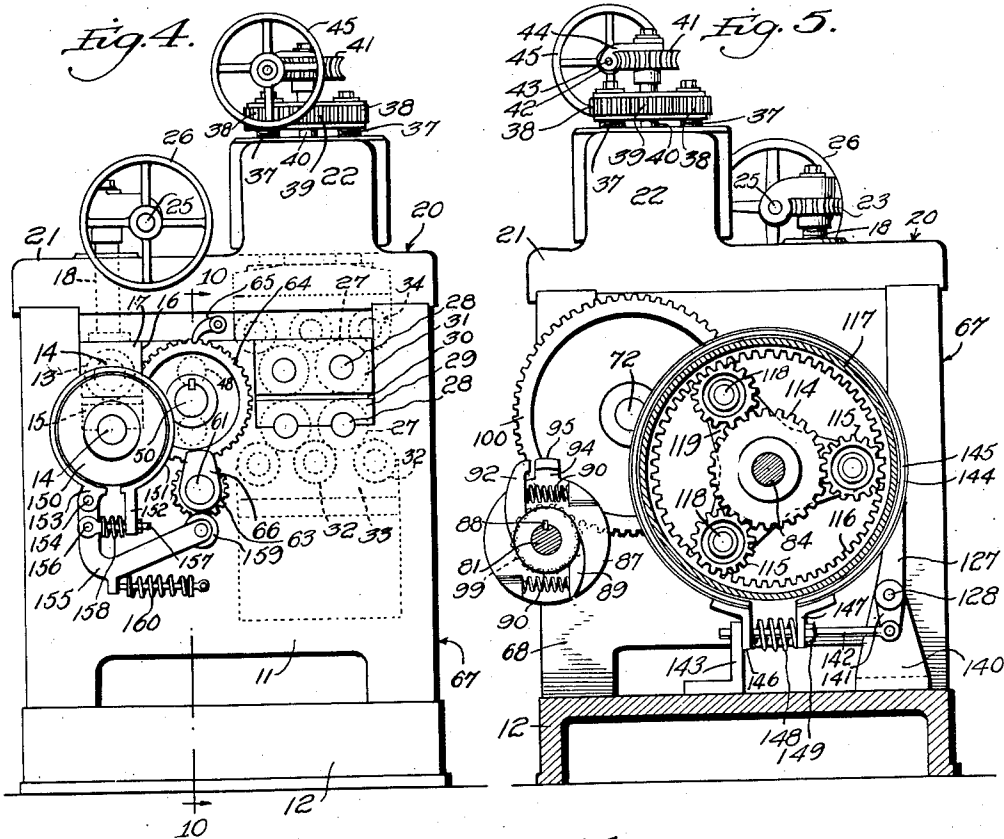
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5 Sheets-Sheet 2



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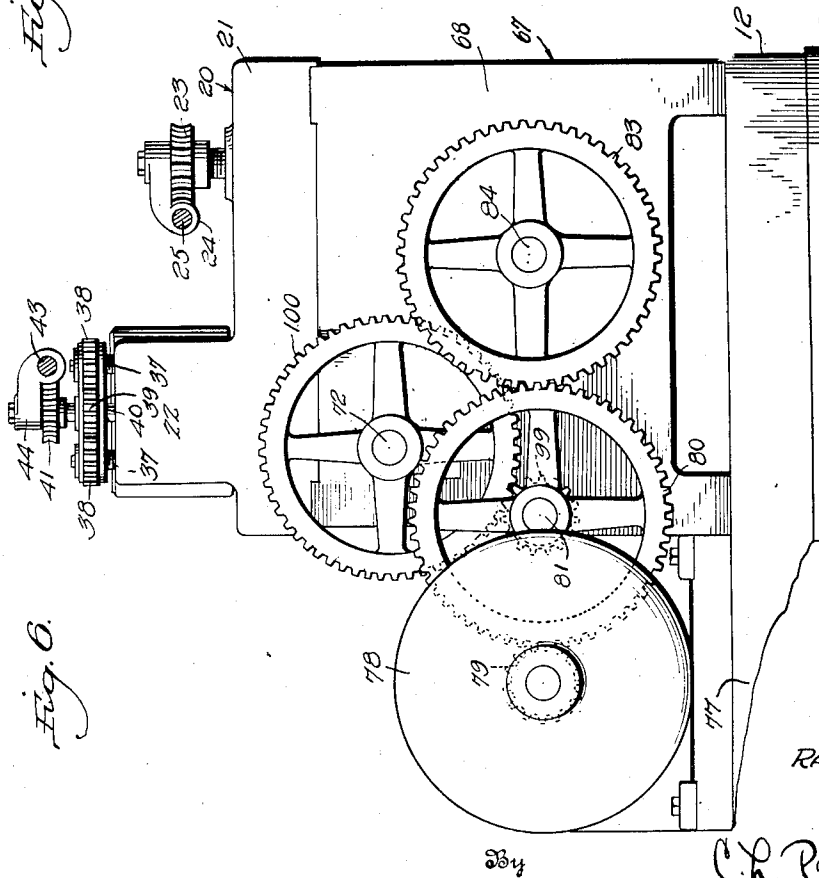
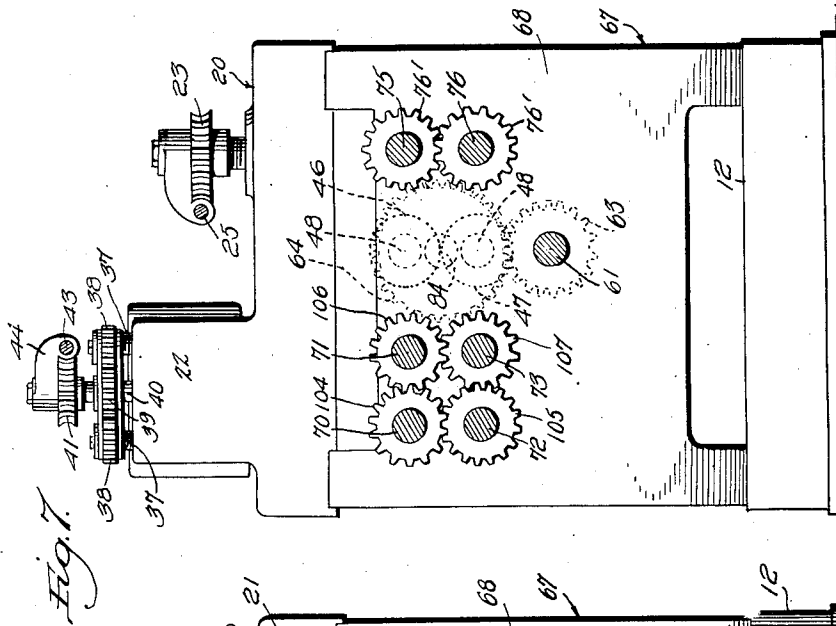
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APPARATUS FOR WORKING SHEET METAL

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5 Sheets-Sheet 3



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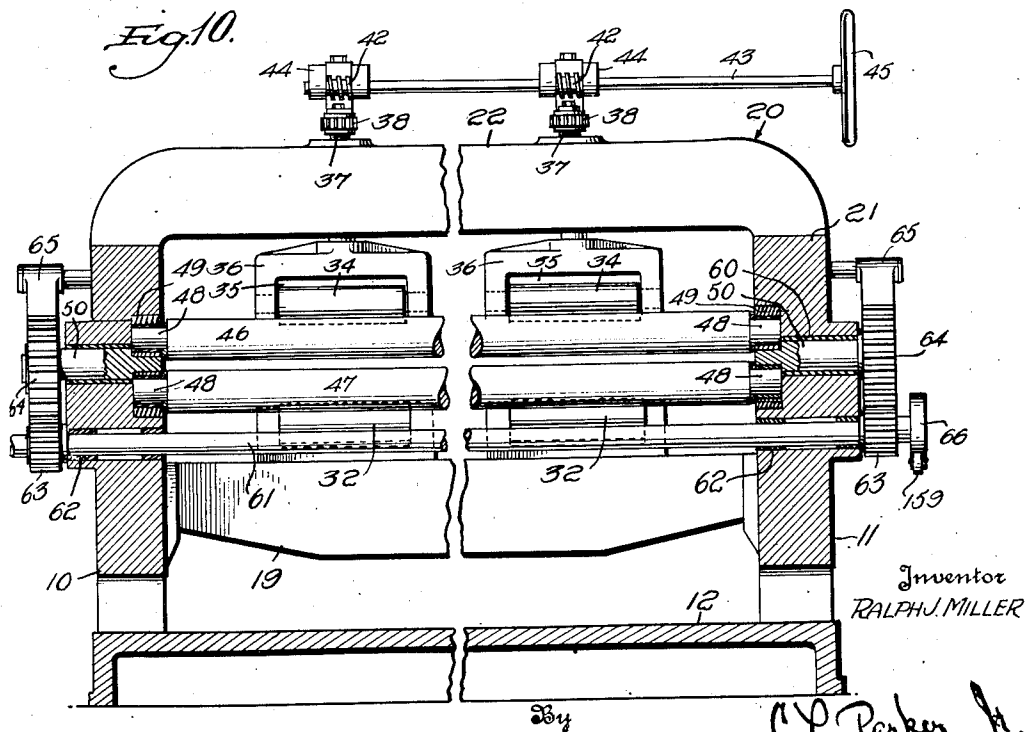
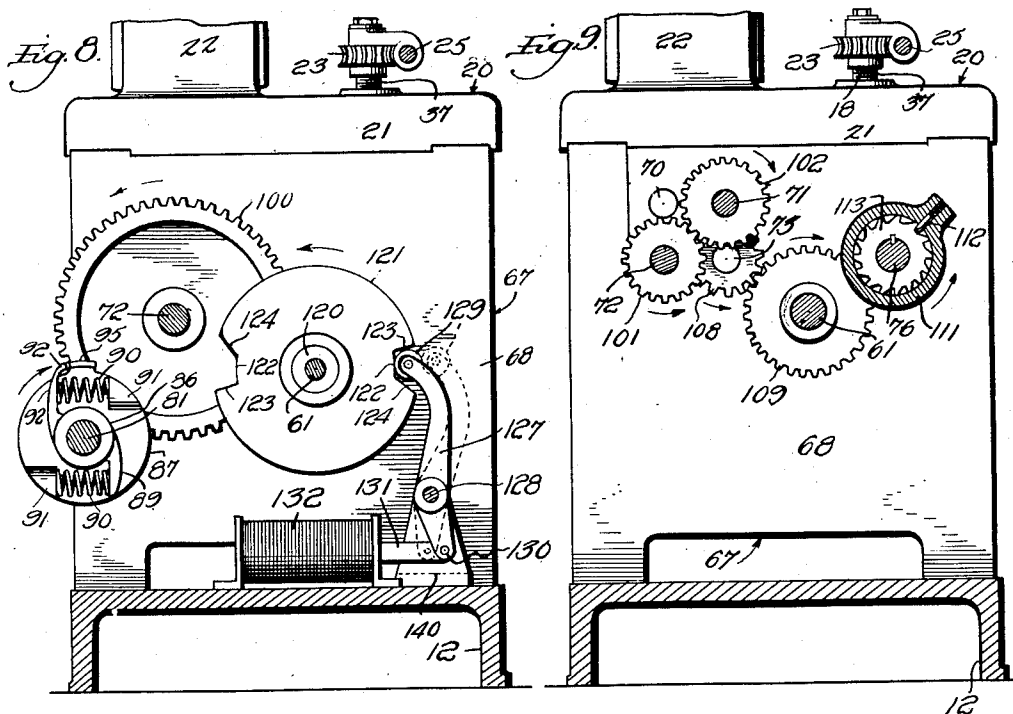
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APPARATUS FOR WORKING SHEET METAL

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5 Sheets-Sheet 4



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APPARATUS FOR WORKING SHEET METAL

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5 Sheets-Sheet 5

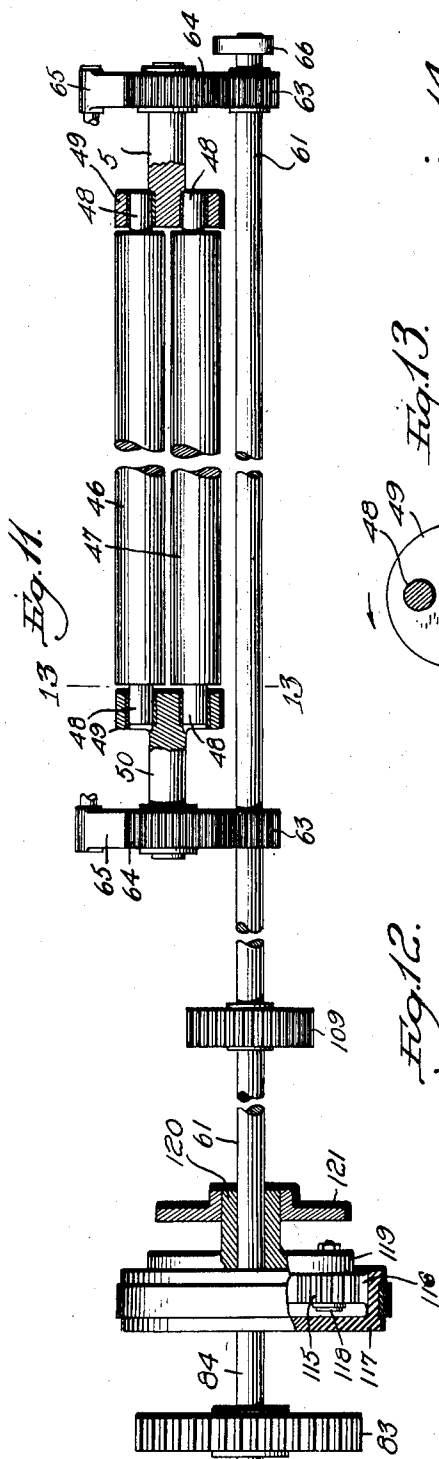


Fig. 11.

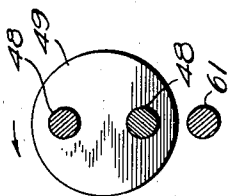


Fig. 13.

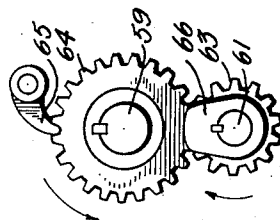


Fig. 14.

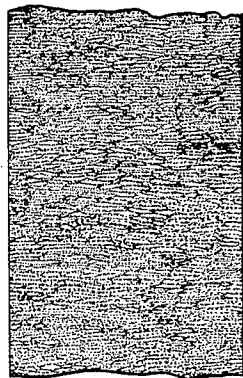


Fig. 16.

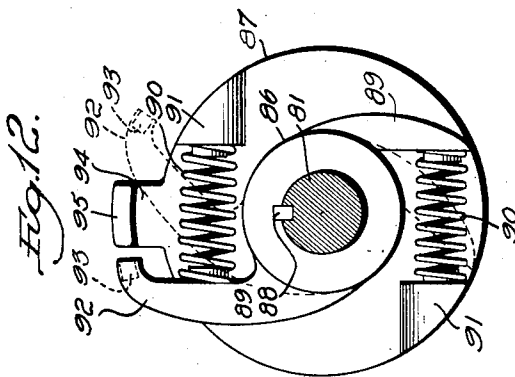


Fig. 12.

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UNITED STATES PATENT OFFICE

2,006,087

APPARATUS FOR WORKING SHEET METAL

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Application May 3, 1930, Serial No. 449,609

18 Claims. (Cl. 153—54)

This invention relates to a sheet metal working apparatus, and more particularly to a machine for treating metal sheets to remove stretcher strains and for other purposes.

5 Certain of the processes involved in the manufacture of steel and other metal sheets effect the stretching of the sheets beyond their normal yielding limit, under which conditions certain strains are developed which produce surface
10 blemishes in the sheets, commonly known as stretcher strains.

An important object of the present invention is to provide an apparatus which is operative for effectively removing stretcher strains from metal
15 sheets.

A further object is to provide an apparatus of the character referred to which is adapted to subject a sheet to a series of alternate bends in different directions while moving through the apparatus, to minimize stretcher strains in the
20 sheets.

A further object is to provide an apparatus for removing stretcher strains from sheets by bending the sheet during its passage through the machine, and for subjecting the sheet to a tensioning action while undergoing the bending operation.

A further object is to provide an apparatus of the general character referred to which is operative, if desired, for providing strips or sheets of metal with irregular ornamental surfaces adapted for making finished articles which may be left plain or may be surface coated.

A further object is to provide an apparatus of the character just referred to which is operative for bending a strip or sheet and subjecting it during such bending to a stretching action which causes the metal of the strip or sheet to be stretched slightly beyond its yield point whereby the resultant sheet will be provided with an irregular crinkled surface, somewhat resembling long grain leather, for ornamental purposes.

A further object is to provide an apparatus having sheet bending means which is normally inoperative to permit the sheet to be readily inserted into the apparatus, and to provide means for rendering the sheet bending means automatically operative after the entering end of a sheet has progressed to a given point in its travel through the apparatus.

A further object is to provide a sheet conditioning apparatus having a pair of feed rolls at the entrance end of the apparatus and a plurality of pulling rolls adjacent the outlet end, the pulling rolls being rotatable at a somewhat higher
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speed than the feed rolls to transmit a tensioning action to the sheet as it passes between such sets of rolls, the apparatus being provided with sheet bending means operative upon the sheet between the feed rolls and the pulling rolls.

A further object is to provide an apparatus wherein a metal sheet is adapted to be subjected to a tensioning action and simultaneously to a bending action to remove stretcher strains from the sheet and to provide means for adjusting the degree of tension to which the sheet is subjected during the bending operation.

A further object is to provide an apparatus of the character above referred to having novel means for rendering the sheet bending means operative after the sheet has progressed a predetermined distance through the apparatus, and for returning the bending means to normal position as the sheet passes from the apparatus.

A further object is to provide an apparatus of the character referred to which is efficient not only for removing stretcher strains from sheets, but which is also readily adapted for use for removing buckles, bulges, coil breaks, or any other unevenness from sheet or strip metal.

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 plan view of the apparatus,

Figure 2 is a transverse section taken substantially on line 2—2 of Figure 1 showing the sheet bending rolls in inoperative position, parts being omitted for the purpose of illustration,

Figure 3 is a sectional view similar to Figure 2 showing the bending rolls in operative position,

Figure 4 is an elevation of one end of the apparatus,

Figure 5 is a section on line 5—5 of Figure 1,

Figure 6 is an elevation of the other end of the apparatus,

Figure 7 is a section on line 7—7 of Figure 1,

Figure 8 is a similar view on line 8—8 of Figure 1,

Figure 9 is a similar view on line 9—9 of Figure 1,

Figure 10 is a section taken substantially on line 10—10 of Figure 4,

Figure 11 is a detail vertical sectional view illustrating the sheet bending means and associated elements, parts being shown in elevation,

Figure 12 is a detail section on line 12—12 of Figure 1,

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Figure 13 is a similar view on line 13—13 of Figure 11.

Figure 14 is a detail elevation illustrating the metal treating roll locking means and the brake operating cam.

Figure 15 is a diagrammatic view of the electrical connections of the apparatus, and,

Figure 16 is a plan view of a fragment of a strip or sheet treated with the apparatus and in accordance with the method to provide an ornamental sheet surface.

Referring to Figures 1 and 10, the numerals 10 and 11 designate a pair of relatively heavy supports spaced from and parallel to each other and adapted to rotatably support a plurality of rolls to be referred to in detail later. The supports 10 and 11, as well as other elements of the apparatus to be described are mounted upon a suitable base 12.

A pair of feed rolls 13 are arranged adjacent the inlet end of the apparatus and are adapted to initially engage the entering ends of sheets fed into the apparatus in a manner to be described. The feed rolls are provided with trunnions 14 the lower of which are mounted in bearings 15 mounted in a slot 16 formed in the supports 10 and 11. The upper trunnions 14 are journaled in bearing blocks 17 which are also mounted in the slot 16 and are vertically adjustable therein. The adjusting means includes upwardly extending screws 18 to be referred to.

The lower portions of the supports 10 and 11 are connected by braces 19, as clearly shown in Figure 10. A cap member indicated as a whole 20 connects the tops of the supports 10 and 11. As shown, the cap member comprises a pair of parallel side members 21 secured against the tops of the supports, and these members are connected to each other by a bridge 22.

The parallel members 21 are provided with openings slidably receiving the screws 18, the upper ends of which are threaded in worm wheels 23 meshing with worms 24 carried by a shaft 25 extending transversely across the tops of the supports. The shaft 25 is supported in any suitable form of bearings carried by the members 21. A hand wheel 26 is adapted to rotate the shaft 25, and thus transmit rotating movement to the worm 23 to move the screws 18, and consequently the bearing blocks 17, vertically according to the thickness of the sheets to be fed between the rolls 13. The adjusting means may be of any desired character and forms no part of the present invention.

Beneath the bridge 22 are mounted a plurality of pairs of upper and lower pulling rolls 27, as shown in Figure 4. The path of movement of the sheet between the upper and lower pulling rolls forms a continuation of the path of the sheet between the feed rolls 13. The feed rolls 13 are spaced a substantial distance from the adjacent pairs of pulling rolls 27, for a purpose to be described. The pulling rolls 27 are provided at their ends with trunnions 28, and the trunnions of the lower rolls are journaled in bearing blocks 29 mounted in slots 30 formed in the supports 10 and 11. The upper trunnions 28 are journaled in vertically slidable bearing blocks 31 mounted in the slots 30.

A plurality of lower pressure rolls 32 contact with the bottom portions of the lower pulling rolls 27, and the pressure rolls are journaled in bearing yokes 33. The pressure rolls serve to support the lower pulling rolls against any possible flexing thereof when under pressure.

A plurality of similar pressure rolls 34 is mounted to engage the upper portions of the upper pulling rolls 27. The rolls 34 are journaled in depending bearing arms 35 carried by yokes 36 which are movable downwardly to adjust the maximum space between the upper and lower rolls 27 so as to cause these rolls to tightly engage the sheets passing therebetween. The yokes 36 are provided with a plurality of upstanding rods or stems 37 which are threaded at their upper ends for engagement in gears 38. The rods 37 and their associated gears 38 are arranged in adjacent pairs and the gears of each pair are connected to each other by an intermediate gear 39 carried by a shaft 40.

The upper end of each shaft 40 is provided with a worm wheel 41 meshing with a worm 42 secured to a shaft 43. This shaft is journaled in suitable bearings 44 mounted on top of the bridge 22. One end of the shaft 43 is provided with a hand wheel 45 which is adapted to be rotated to rotate the worms 42 and worm wheels 41. This rotating movement is transmitted to the gears through the intermediate gears 39, thus imparting movement to the rods 37 and yokes 36 to vary the space between the upper and lower rolls 27 for the purpose described. The adjusting means described forms no part of the present invention and any suitable adjusting means may be employed. It will be apparent that the pressure rolls 34 also function in the same manner as the pressure rolls 32 to prevent any upward flexing of the upper feeding rolls 27.

Means are provided between the rolls 13 and the adjacent rolls 27 for bending the sheets as they pass through the apparatus. Referring to Figures 2 and 3, the numerals 46 and 47 designate a pair of metal working rolls which are normally arranged in the position shown in Figure 2. The metal working rolls are preferably spaced apart a distance substantially greater than the thickness of the sheet as shown. This space, when the metal working rolls are in normal position, is arranged in the same horizontal plane as the spaces between the upper and lower rolls 13 and the upper and lower rolls 27 as shown in Figure 2.

The ends of the rolls 46 and 47 are provided with trunnions 48 journaled in plates 49, as shown in Figure 11. Relatively heavy trunnions 50 are carried by the plates 49 and project outwardly therefrom in axial alignment with each other. The axis of the trunnions 50 lies parallel to and midway between the axes of rotation of the rollers 46 and 47. As shown in Figure 10, the trunnions 50 are journaled in bearings 60 carried by the supports 10 and 11.

A counter shaft 61 is mounted below the metal working rolls 46 and 47, and has its axis parallel thereto. The shaft 61 is journaled in bearings 62 carried by the supports 10 and 11, as shown in Figure 10, and outwardly of each of the supports, the shaft 61 is provided with pinions 63 meshing with gears 64 carried by the extremities of the trunnions 50. In the embodiment of the invention illustrated, the gears 64 are twice the diameter of the pinions 63, whereby rotation of the shaft 61 through a half revolution is adapted to simultaneously rotate the plates 49 through a quarter circle about the axis of the trunnions 50. When this action takes place, in a manner to be described, the metal working rolls will be swung from the inoperative position shown in Figure 2 to the operative position illustrated in Figure 3.

As shown in Figures 10 and 11, means is provided for holding the metal working rolls 46 and

47 in operative position by preventing reverse rotation of the plates 49. Pawls 65 are pivotally connected to the supports 10 and 11, and are adapted to engage the teeth of each gear 64 after the latter have been rotated by the shaft 61, and accordingly it will be apparent that the shafts 50 can be rotated only in one direction. For a purpose to be described, the outer end of the shaft 61 is provided with a cam 66.

As shown in Figure 1, the base 12 extends a substantial distance to one side of the various rolls and associated elements described, and a supporting structure indicated as a whole by the numeral 67 is mounted upon the projecting portion of the base. The supporting structure 67 includes a plurality of vertical members designated generally by the reference numeral 68, and these vertical members are provided with a number of bearings, which need not be referred to in detail, to support a number of shafts to be described.

The inner trunnion associated with each of the pulling rolls 27 is provided with a driving connection 69, illustrated in Figure 1 as comprising a relatively heavy flat plate having enlarged end portions of substantially semicircular cross section adapted to be connected to the shafts with which they are associated. The driving members 69 are respectively connected to the inner ends of shafts 70 and 71, arranged in alignment with the upper rolls 27, and similar parallel shafts 72 and 73 arranged in alignment with the lower rolls 27. Similarly, the inner trunnions of the feed rolls 13 are connected by driving members 74 to upper and lower shafts 75 and 76 arranged respectively in alignment with the upper and lower feed rolls. The shafts 75 and 76 are connected together to be simultaneously driven by gears 76'. The various shafts referred to are journaled in suitable bearings carried by the supporting structure 67.

Beyond the supporting structure 67, the base 12 is transversely enlarged as at 77, and supports a suitable motor 78 forming a power source for the apparatus. The motor shaft carries a driving pinion 79 meshing with a gear 80 carried by a shaft 81, and this shaft is journaled in a suitable bearing 82 carried by the base. The gear 80 meshes with a similar gear 83 carried by a shaft 84 journaled in a bearing 85.

The shaft 81 is provided with cushion means for driving certain of the elements of the apparatus. Referring to Figures 1 and 12, the numerals 86 and 87 designate a pair of relatively rotatable members, the former of which is keyed or otherwise secured to the shaft 81, as indicated at 88. The member 86 is provided with a pair of projecting arms 89, and these arms provide seats for one end of each of a pair of springs 90, which may be of any desired type. The opposite ends of the springs seat against projections 91 extending laterally from the adjacent face of the member 87. It will be apparent that the springs 90 provide cushion driving means for transmitting rotative forces from the member 86 to the member 87.

One of the arms 89 projects a substantial distance beyond the periphery of the member 87, as indicated at 92, and is provided on one side with a contact 93. The member 87 is provided with a radial projection 94 carrying a suitably insulated contact 95 adapted to engage the contact 93 when the latter moves to the dotted line position shown in Figure 12, under conditions to be referred to later. Any suitable means may be employed for

transmitting current to the contact 95, and in Figure 1 the rotatable member 87 is illustrated as being provided with a contact ring 96 engaged by a suitably supported brush 97.

The rotatable member 87 is carried by a shaft 98 suitably journaled in the adjacent portion of the structure 67, and the shaft 98 carries a driving pinion 99. A gear 100 meshes with the pinion 99 and is carried by the shaft 72 as shown in Figure 6. Referring to Figures 1 and 9, the numeral 101 designates a gear carried by the shaft 72 and meshing with a similar gear 102 carried by the shaft 71. Accordingly it will be apparent that rotation of the shaft 72 is transmitted to the shaft 71 and these shafts rotate in opposite directions. The shaft 70 terminates at the point 103 (see Figure 1) and at a point spaced from its extremity, this shaft is provided with a gear 104 meshing with a similar gear 105 carried by the shaft 72, as shown in Figure 7. Accordingly it will be apparent that the shaft 70 will be driven by the shaft 72, to which power is transmitted in the manner referred to above. Similarly, the shaft 71 carries a gear 106 meshing with a gear 107 carried by the shaft 73, and accordingly the latter shaft will be driven from the shaft 71. It will be apparent from the driving connections just described that the pulling rolls will be constantly driven as long as the motor 78 is in operation, but it also will be apparent that a suitable clutch may be provided as, for example, in the shaft 81 to stop the rotation of the pulling rolls when desired.

As shown in Figures 1 and 9, the shaft 73 also carries a pinion 108 meshing with an idler gear 109 freely rotatable on the shaft 61 previously described. The gear 109, in turn, meshes with a gear 110. This gear is secured to a cylindrical member 111 carrying a spring pressed pawl 112, as shown in Figure 9, and this pawl is adapted to engage the teeth of a ratchet 113 carried by the shaft 76. It will be apparent that rotation of the member 111 by the gear 110 will drive the shaft 76 in one direction. As will become apparent, the pawl 112 prevents reverse rotation of the shaft 76, but permits the latter to rotate at a greater rate of speed than the member 111, for a purpose to be described.

Referring to Figures 1 and 5, it will be noted that means is provided for transmitting power from the shaft 84 to the shaft 61 arranged in alignment therewith. In the drawings, a planetary transmission has been illustrated, but it will be apparent that any form of transmission means may be employed. A gear 114 is carried by the shaft 84 and meshes with a series of planetary gears 115, these gears in turn meshing with a sun or ring gear 116 formed within a drum 117. The pinions 115 are rotatably supported by trunnions 118 carried by a spider 119, as shown in Figures 5 and 11. The spider 119 is provided with a hub 120 connected to the shaft 61.

A cam wheel 121 is mounted on the hub 120, and is provided with diametrically opposite depressions 122 each of which has one side substantially radially arranged as at 123 and its opposite side slightly sloping as at 124. The cam wheel is provided at diametrically opposite points with contacts 125 shown diagrammatically in Figure 15, but it will be apparent that these contacts are arranged to one side of the cam wheel in order that the high points or cylindrical portions 126 of the cam wheel may be free for a purpose to be described.

Referring to Figures 5 and 8, the numeral 127

designates a lever arm connected to a shaft 128 and provided at its upper end with a roller 129 adapted to engage the cam wheel 121. The lower end of the lever 127 is connected as at 130 to the outer end of a bar 131 forming the armature of a solenoid 132. It will be apparent that energization of the solenoid 132 is adapted to swing the lower end of the lever 127 inwardly to free the roller 129 from either of the cam depressions 122 in which it may be arranged.

A source of current 133 is provided for the solenoid 132. One terminal of the source is connected to one end of the winding of the solenoid by a wire 134, while the opposite end of the solenoid is connected by a wire 135 to a brush arm 136, adapted to engage one of the contacts 125. A similar brush 137 also is adapted to engage one of the contacts 125 to afford electrical connection between the brushes, and the brush 137 is connected by a wire 138 to the contact 95 of the cushion driving means described. The other terminal of the source is connected to the contact 93 by a wire 139.

Movement of the lever arm 127, upon energization of the solenoid 132, is utilized for preventing rotation of the drum 117 to render the planetary transmission operative. Referring to Figure 5, it will be noted that the shaft 128 is journaled in bearings 140, and this shaft carries a depending arm 141 connected to one end of a push rod 142. The free end of the rod 142 extends through a guide 143. A brake band 144 surrounds the drum 117 and is provided with a suitable lining 145 adapted to engage the drum 117. The free ends of the band 144 are provided with lugs 146 and 147, the former of which engages against the guide 143 which serves as a stop for the lug. A coil spring 148 surrounds the rod 142 and abuts the lugs 146 and 147 and a nut or collar 149 is carried by the rod 142 to engage against the outer face of the lug 147. It will be apparent that outward swinging movement of the upper end of the lever 127 is adapted to move the lug 147 inwardly, thus bringing the brake band into engagement with the drum 117 to prevent rotation thereof.

As previously stated, the ratchet driving means illustrated in Figure 9 is adapted to rotate the shaft 76 at a fixed maximum speed, although the shaft is adapted to be rotated at a higher speed than that imparted to it by the ratchet means. However, braking means is provided for limiting the speed of rotation of the shaft 76 when the latter overruns the ratchet tooth 112. Referring to Figures 4, 10 and 11, the numeral 150 designates a brake drum carried by the outer trunnion 14 of the lower feed roll 13. This drum is adapted to be engaged by a brake band 151 having a fixed lug 152 connected to one end thereof. A movable lug 153 is carried by the opposite end of the brake band and is pivotally connected as at 154 to one end of a lever 155. This lever is pivotally connected intermediate its ends as at 156 to one end of a rod 157, extending through the fixed lug 152 and a spring 158 surrounds the rod 157 and tends to urge the ends of the brake band away from each other.

A roller 159 is carried by the free end of the lever 155 and engages against the cam 66 previously described. A spring 160 is operative to pull the free end of the lever 155 inwardly to retain the roller 159 in engagement with the cam 66.

The operation of the apparatus is as follows:

The pulling rolls 27 are simultaneously rotated

at equal speeds through the gearing connections previously described. Attention is invited to the fact that the drive from the motor passes through the cushion driving means, and when no sheets are passing through the apparatus, no resistance will be offered to the rotation of the rolls 27, and hence the springs 90 will be in a substantially open position, whereby the relatively rotatable members 86 and 87 and the contacts 93 and 95 will occupy the relative positions shown in solid lines in Figure 12. The metal working rolls 46 will be in the inoperative position illustrated in Figure 2, and the contact arms 136 and 137 will occupy the normal position shown in Figure 15, in engagement with one of the contacts 125.

As previously stated, the feed rolls 13 are constantly driven through the medium of the gears 108, 109 and 110, and the ratchet driving means illustrated in Figure 9. The speed of rotation of the feed rolls 13, however, is materially less than the speed of rotation of the pulling rolls 27, this difference in speed being determined by the driving gearing of the several rolls. The rolls 13 are properly spaced to permit the entrance therebetween of the entering end of a sheet of a given thickness in order that the rolls 13 may positively drive the sheets, and the rolls 27 are similarly arranged so as to tightly engage the sheet.

The sheet is interposed between the rolls 13 and is advanced thereby between the rolls 46 and 47, which do not initially engage the sheet, after which the sheet comes into engagement with the first pair of rolls 27. The greater speed of rotation of the rolls 27 tends to pull the sheet faster than the linear speed of the rolls 13, and resistance to the rotation of the rolls 27 is accordingly introduced. This resistance is transmitted to the various shafting and gearing employed for rotating the rolls 27, and thus will be transmitted to the cushion driving means illustrated in Figure 12.

As previously stated, the contacts 93 and 95 normally occupy the position shown in solid lines in Figure 12, and when resistance to the rotation of the rolls 27 is introduced relative rotation is imparted to the members 86 and 87 with the result that the contact 93 moves across the contact 95 to assume the dotted line position illustrated in Figure 12. Referring to Figure 15, it will be apparent that the circuit for the solenoid 132 will be completed, while the contacts 93 and 95 are in engagement with each other, and during this interval the solenoid will retract its armature, thus swinging the lever 127 about its pivot to move the roller 129 free of the associated cam notch 122, and at the same time, the rod 142 will be pushed inwardly to apply the brake against the drum 117.

Rotation of the drum 117 will be prevented under the conditions stated, and thus rotation of the gear 114 will effect rotation of the pinions 115, and accordingly the spider 119, and thus rotating movement is transmitted in turn to the shaft 61. As soon as the shaft 61 starts to rotate it moves the cam disk 121, and the cam notch 122 in which the roller 129 previously rested will pass beyond the roller and the latter will be supported upon the cylindrical or high point of the cam wheel, thus retaining the brake in operative position after the contact 93 passes beyond the contact 95, and after the contact 125 has passed from beneath the brushes 136 and 137.

Under the conditions referred to, it will be apparent that the cam wheel 121 will be rotated through a half revolution, at the completion of

which the roller 129 will drop into the next cam notch 122 to release the brake from the drum 117. The rotation of the shaft 61 is imparted to the plates 49 through the gears 63 and 64, and thus the metal working rolls 46 and 47 will be revolved. As previously stated, the diameter of the gear 64 is double the diameter of the gear 63, and since the cam wheel 121 will have moved through half a revolution, it will be apparent that the plates 49 and associated elements will be rotated through a quarter circle about the axis of the trunnions 59. The rollers 46 and 47 and the elements connected thereto constitute in effect, a reel which will be rotated automatically in the manner referred to upon the entrance of the sheet between the rolls 27, to cause the rolls 46 and 47 to assume the positions shown in Figure 3.

As previously stated, the shaft 76 is adapted to overrun the pawl tooth 112, but the brake 151 (see Figure 4) is adapted to limit the overrunning movement. Upon rotation of the shaft 61 in the manner previously described, the cam 66 will be brought into engagement with the roller 159, thus moving the lever 155 to apply the brake 151 against the drum 150. The nut on the rod 157 is adapted to adjust the brake so that the resistance of the latter against the drum 150 may be varied as desired. Accordingly it will be apparent that since the sheet will be tightly engaged both by the rolls 13 and the rolls 27, and that since these sets of rolls rotate at differential speeds, the sheet will be subjected to a tensioning action as it passes through the apparatus.

It will be noted that when the reel swings to operative position, it takes up considerably on the length of the sheet, and the brake is released during such operation so as to prevent placing on the sheet such a tension as to cause the breaking thereof. The brake is automatically brought into operation however, as the reel approaches operative position. The resistance offered to the movement of the sheet as it enters between the pulling rolls is sufficient to operate the relatively movable members of the cushion drive for the purpose stated.

It will be apparent that the tension of the sheet will tend to move the rollers 46 and 47 to turn the reel back to normal position, and after the reel has been moved to operative position, the pawl 65 (see Figure 14) will prevent reverse rotation of the reel by engaging the teeth of the gear 64. In this connection it may be stated that while the reel is illustrated as being adapted to turn through a quarter circle to operative position, the degree of turning movement may be varied according to the position of the cam notches 122. Under any conditions, however, the rollers 46 and 47 will be projected through the path of the sheet at an equal extent from opposite sides thereof.

When the cam wheel 121 is turned to the operative position described, the brushes 136 and 137 will come into engagement with the other contact 125, and obviously will remain in such position during the passage of the sheet through the apparatus. At the same time it will be apparent that the brush 93 will be retained in the dotted line position illustrated in Figures 12 and 15, since the play between the relatively rotatable members 86 and 87 will be constantly taken up while the sheet is passing through the apparatus. As soon as the sheet has passed beyond the rolls 13, 46 and 47, the resistance against the rotation of the rolls 27 will be released, and accordingly the contact 93 will return to operative position.

During the return movement of the contact 95 and the other elements of the cushion drive to normal position, the contact referred to passes across the contact 95 in engagement therewith, thus energizing the solenoid 132 in the manner previously described. The lever 127 again will be actuated to lift the roller 129 from the second cam notch 122, and to apply the brake against the drum 117, whereupon rotation again will be imparted to the shaft 61 to return the reel to normal position.

Two sets of the pulling rolls 27 have been illustrated, but any number may be employed as desired. It will be noted that these rolls operate in the same manner as the usual leveling apparatus, and accordingly the sheets, after being treated to remove the stretcher strains, will be levelled by the rolls 27 and will be discharged from the apparatus substantially flat.

From the foregoing it will be apparent that the present apparatus provides novel means for bending a sheet of metal during its movement through the apparatus by projecting the metal working rolls through the plane of movement of the sheet to an equal extent from opposite sides thereof and this action is very effective for eliminating stretcher strains. The differential rotation of the rolls 13 and 27 imparts a tensioning action to the sheet simultaneously with the bending action, and it has been found that this tensioning action materially increases the efficiency of the apparatus to remove stretcher strains, thus providing a resultant sheet of remarkably uniform internal and surface structure. The sheet is thus materially improved in quality, and results in a corresponding improvement in the quality of the products manufactured therefrom.

The apparatus is also operative for providing certain classes of strips or sheets with ornamental surfaces. For example, it has been found that if strips or sheets of cold rolled mild steel are passed through the apparatus, the surfaces of such strips or sheets will be provided with ornamental surfaces somewhat similar to long grain leather, as illustrated in Figure 15 of the drawings. This result is believed to be due to the breaking of the hard surface structure of strips or sheets of the character referred to, and provides a very attractive surface which may be left plain and polished, or may be coated with suitable surface coating compositions.

The invention has been described above particularly with reference to its application for removing stretcher strains from sheet metal. In the manufacture of sheet metal, however, stretcher strains are not the only difficulty encountered. For example, finished metal sheets are often buckled or bulged at different points in their surfaces, and it is desired to remove this unevenness. Furthermore, in the manufacture of strip metal, it is the common practice to wind the strips on reels, and when these strips are unwound, they bend rather sharply transversely of the strips at spaced points therealong, such bends being commonly known in the industry as "coil breaks". It has been found that any unevenness in a sheet or strip of metal of the character referred to readily may be removed by passing the sheet or strip through the apparatus in accordance with the method disclosed above.

It is to be understood that the form of the invention herein described is to be taken as a preferred example of the same and that various changes in the size, shape and arrangement of parts may be made without departing from the

spirit of the invention or the scope of the sub-joined claims.

I claim:

1. Apparatus of the character described comprising upper and lower feed rolls, upper and lower pulling rolls spaced from said feed rolls and defining therewith a path of travel for a sheet passing between said rolls, means for driving all of said rolls whereby said pulling rolls rotate at a greater rate of speed than said feed rolls, sheet working members arranged between said feed rolls and said pulling rolls respectively above and below the normal path of travel of the sheet, and means for projecting said sheet working members through the normal plane of the sheet to an equal extent on opposite sides thereof.

2. Apparatus of the character described comprising upper and lower feed rolls, upper and lower pulling rolls spaced from said feed rolls and defining therewith a path of travel for a sheet passing between said rolls, a pair of sheet working rolls arranged between said feed rolls and said pulling rolls and adapted to project respectively upwardly and downwardly through the normal plane of the sheet, and means for subjecting the sheet transversely of said sheet working rolls to a tensioning action greater than is effected by said sheet working rolls.

3. Apparatus of the character described comprising upper and lower feed rolls, upper and lower pulling rolls spaced from said feed rolls and defining therewith a path of travel for a sheet passing between said rolls, means for driving all of said rolls whereby said pulling rolls rotate at a greater rate of speed than said feed rolls, a pair of sheet working rolls arranged between said feed rolls and said pulling rolls and normally disposed in inoperative position respectively above and below the normal path of travel of the sheet, and means for projecting said sheet working rolls respectively upwardly and downwardly through the normal plane of the sheet.

4. Apparatus of the character described comprising upper and lower feed rolls, upper and lower pulling rolls spaced from said feed rolls and defining therewith a path of travel for a sheet passing between said rolls, a reel arranged between said feed rolls and said pulling rolls and rotatable about an axis coincident with the plane of the sheet, said reel including a pair of metal working rolls equidistantly spaced on opposite sides of the axis of said reel and normally disposed respectively above and below the normal path of travel of the sheet, means for rotating said reel through a partial revolution to project said metal working rolls to operative position through the normal plane of the sheet to an equal extent from opposite sides thereof, and means for subjecting the sheet transversely of said metal rolls when the latter are in operative position to a tensioning action greater than is effected by said metal working rolls.

5. Apparatus of the character described comprising upper and lower feed rolls, upper and lower pulling rolls spaced from said feed rolls and defining therewith a path of travel for a sheet passing between said rolls, means for driving all of said rolls whereby said pulling rolls rotate at a greater rate of speed than said feed rolls, a reel arranged between said feed rolls and said pulling rolls and including a pair of metal working rolls normally arranged above and below the normal path of travel of the sheet, the axis of rotation of said reel being substantially coincident with the plane of the sheet, and means for

rotating said reel through a partial revolution to project said metal working rolls through the normal plane of the sheet to an equal extent from opposite sides thereof.

6. Apparatus of the character described comprising upper and lower feed rolls, upper and lower pulling rolls spaced from said feed rolls and defining therewith a path of travel for a sheet passing between said rolls, means for driving all of said rolls whereby said pulling rolls rotate at a greater rate of speed than said feed rolls, a reel arranged between said feed rolls and said pulling rolls and rotatable about an axis coincident with the plane of the sheet, said reel including a pair of metal working rolls equidistantly spaced on opposite sides of the axis of said reel and normally disposed respectively above and below the normal path of travel of the sheet, and means for rotating said reel through a partial revolution to project said metal working rolls through the normal plane of the sheet to an equal extent from opposite sides thereof.

7. Apparatus of the character described comprising upper and lower feed rolls between which a sheet is adapted to be introduced from one side thereof, upper and lower pulling rolls spaced from the opposite side of said feed rolls and between which the sheet is adapted to travel, means for driving all of said rolls whereby said pulling rolls rotate at a greater rate of speed than said feed rolls, sheet working members normally arranged respectively above and below the path of travel of the sheet between said feed rolls and said pulling rolls, and means operative upon engagement of the sheet by said pulling rolls for projecting said sheet working members through the plane of the sheet on opposite sides thereof.

8. Apparatus of the character described comprising upper and lower feed rolls between which a sheet is adapted to be introduced from one side thereof, upper and lower pulling rolls spaced from the opposite side of said feed rolls and between which the sheet is adapted to travel, means for driving said pulling rolls at a greater rate of speed than said feed rolls whereby the sheet will be subjected to a tensioning action, a pair of sheet working rolls arranged between said feed rolls and said pulling rolls and normally disposed respectively above and below the plane of the sheet, and means operative upon the subsection of the sheet to the tensioning action for projecting said sheet working rolls respectively upwardly and downwardly through the normal plane of the sheet.

9. Apparatus of the character described comprising upper and lower feed rolls between which a sheet is adapted to be introduced from one side thereof, upper and lower pulling rolls spaced from the opposite side of said feed rolls and between which the sheet is adapted to travel, means for driving said pulling rolls at a greater rate of speed than said feed rolls whereby the sheet will be subjected to a tensioning action, a reel arranged between said feed rolls and said pulling rolls and rotatable about an axis coincident with the plane of the sheet, said reel including a pair of metal working rolls equidistantly spaced on opposite sides of the axis of said reel and normally disposed respectively above and below the normal path of travel of the sheet, and means operative upon the subsection of the sheet to the tensioning action for rotating said reel through a partial revolution to project said metal working rolls to operative position through the normal

plane of the sheet to an equal extent from opposite sides thereof.

10. Apparatus constructed in accordance with claim 6 provided with a power source for rotating said feed rolls and said pulling rolls, the means for rotating said reel including a cushion driving device between said source and said pulling rolls operative when the turning movement of said pulling rolls is resisted by the entrance therebetween of the sheet to effect turning movement of said reel.

11. Apparatus of the character described comprising upper and lower feed rolls, upper and lower pulling rolls spaced from said feed rolls and defining therewith a path of travel for a sheet passing between said rolls, a pair of sheet working rolls arranged between said feed rolls and said pulling rolls and normally disposed respectively above and below the normal path of travel of the sheet, means for projecting said sheet working rolls respectively upwardly and downwardly through the normal plane of the sheet to an equal extent, means operative during the operation of said last named means for tensioning the sheet substantially at right angles to said working rolls, and means for varying the amount of tension placed on the sheet.

12. Apparatus of the character described comprising upper and lower feed rolls, upper and lower pulling rolls spaced from said feed rolls and defining therewith a path of travel for a sheet passing between said rolls, a pair of sheet working rolls arranged between said feed rolls and said pulling rolls and normally disposed respectively above and below the normal path of travel of the sheet, means for projecting said sheet working rolls respectively upwardly and downwardly through the normal plane of the sheet to an equal extent, means for driving said feed rolls and said pulling rolls at differential speeds to tension the sheet passing therebetween during the operation of said last named means, and means for retarding the speed of rotation of said feed rolls to vary the tension of the sheet.

13. Apparatus of the character described comprising upper and lower feed rolls, upper and lower pulling rolls spaced from said feed rolls and defining therewith a normal path of travel for a sheet passing between said rolls, means for positively driving said pulling rolls, means including an overrunning clutch for driving said feed rolls at a slower rate of speed than said pulling rolls, a pair of sheet working rolls arranged between said feed rolls and said pulling rolls and normally arranged in inoperative position respectively above and below the normal path of travel of the sheet, means for projecting said sheet working rolls respectively upwardly and downwardly to operative position through the normal plane of the sheet to an equal extent, and a brake

for retarding the overrunning speed of said feed rolls.

14. Apparatus constructed in accordance with claim 13 provided with means automatically operative upon movement of said metal working rolls to operative position for rendering said brake effective.

15. Apparatus constructed in accordance with claim 13 provided with a power source for driving said feed rolls and said pulling rolls, the means for projecting said metal working rolls to operative position including a pair of relatively movable members constituting part of a cushion drive device between said power source and said pulling rolls and operative when moved relatively in one direction for projecting said metal working rolls to operative position.

16. Apparatus constructed in accordance with claim 13 provided with a power source for driving said feed rolls and said pulling rolls, the means for projecting said metal working rolls to operative position including a pair of relatively movable members constituting part of a cushion drive device and operative upon the entrance of the sheet between said pulling rolls for projecting said metal working rolls to operative position, and means automatically operative upon movement of said metal working rolls to operative position for rendering said brake effective.

17. Apparatus of the character described comprising upper and lower feed rolls, upper and lower pulling rolls spaced from the feed rolls and defining therewith a path of travel for a sheet passing between said rolls, sheet working means arranged between said feed and pulling rolls and adapted to project through the normal plane of the sheet to subject it to a progressive bending action, means for subjecting the sheet to a tensioning action transversely of the sheet working rolls, and means for varying the degree of tension to which the sheet is subjected.

18. Apparatus of the character described comprising upper and lower feed rolls, upper and lower pulling rolls spaced from said feed rolls and defining therewith a normal path of travel for a sheet passing between said rolls, means for positively driving said pulling rolls, means including an overrunning clutch for driving said feed rolls at a slower rate of speed than said pulling rolls, sheet working means arranged between said feed and pulling rolls and normally arranged out of the normal path of travel of the sheet, means for projecting said sheet working means through the normal path of travel of the sheet to subject the latter to a progressive bending action between said feed and pulling rolls, and a brake for retarding the overrunning speed of said feed rolls.

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