It is one of the purposes of a flexing machine of this character to flex or work metal sheets to prepare them for deep drawing, and at the same time prevent the formation or development of irregularities such as are known as stretcher strains or Luder's lines, commonly called worm or alligator skin, on the surface of the metal after the draw has been completed. Such flexing is desirable especially in deep drawing as it will reduce to a minimum the percentage of scrap, often caused by the outer surfaces tearing or rupturing in the dies, and also prevents the formation of irregular surface marks.

In deep drawing the permanent deformation of steel takes place by alternate slipping and work strengthening, that is, the work strengthening increases resistance to slip of the different grains or groups of grains, and as steel is not a perfect homogeneous substance and the distribution of stresses is not absolutely uniform during the process of drawing, some grains or groups of grains will slip more than the neighboring group causing a deformation with due reduction of area of the steel, and it is the difference in thickness thus produced that causes the severe surface markings known as Luder's lines.

If the weakening effect on the steel by reduction of cross-section is not made up by the work strengthening process, further stress will finally cause a rupture, and breakage or cracking will occur in the stamping.

In order to eliminate stretcher strains it has been found that it is necessary to plastically deform the metal by cold working to a point where the rate of work strengthening has risen to a value greater than that of weakening due to reduction in cross-section, and when the steel is used within a short time for deep drawing there will not occur any breaking or Luder's lines due to this effect.

It is one of the objects of the present invention to overcome the difficulties and objections here-tofore existing in such processes, and to provide an improved machine for flexing the metal in such a manner that the flexing or leveling unit embodies a number of spaced co-operating rollers arranged in staggered relation, and in such a manner that the top and bottom rollers on the entering side will be in closer proximity to each other than the co-operating rollers on the leaving side.

The rollers are preferably of very small diameter, with the result that the sheet will be subjected to a great amount of flexing in the first part of the unit, whereas the latter part of the unit may be employed for the purpose of leveling or straightening the sheet before it leaves the unit.

A further object is to provide an improved machine of this character in which the co-operating series of rollers are not only laterally adjustable with respect to each other, but one of the series is mounted upon a swinging support so that all of the rollers of that series may be shifted with respect to the rollers of the other or co-operating series to vary the relative positions of the co-operating series.

A further object is to provide in a machine of this character improved means whereby the flexing rollers will be backed by rollers of larger diameter to prevent them from flexing, and the drives of the feed rollers will be equipped with mechanism that will allow free wheeling movement to permit the additional speed necessary due to the relative changing position of the flexing rollers.

To the attainment of these ends and the accomplishment of other new and useful objects as will appear the invention consists in the features of novelty in substantially the construction, combination and arrangement of the several parts hereinafter more fully described and claimed in the accompanying drawings illustrating this invention, and in which

Figure 1 is a top plan view of a machine of this character constructed in accordance with the principles of this invention.

Figure 2 is a front elevation of Figure 1 with parts omitted and parts broken away.

Figure 3 is a right hand end elevation, on an enlarged scale, of Figure 1 and with parts omitted.

Figure 4 is a left hand elevation of Figure 1 on an enlarged scale, and with parts omitted.

Figure 5 is an enlarged detail sectional view taken on line 5—5 Figure 1.

Figure 6 is a view taken on line 6—6 Figures 1 and 7, on an enlarged scale and with parts omitted.

Figure 7 is a detail sectional view, on an enlarged scale, taken on line 1—1 Figure 1.

Figure 8 is an enlarged detail sectional view of the levelling rollers.

Figure 9 is an enlarged detail sectional view of the flexing rollers and unit shown in section with the fluid pressure actuating means for controlling the operation thereof.

Figure 10 is a detail elevation taken on line 10—10 Figure 9.
The hub of the wheel 45 is preferably recessed as at 46 and engages over a portion 47 of the stationary member 44. Encompassing the rod 43 is a spring 48 one end of which abuts the bearing 42 and the other end is recessed into a nut or member 42a, the latter being threaded as at 48b into the stationary member 44, apertures 48c being preferably provided and which open through the periphery of the nut 48a for the reception of an implement by means of which the nut or member 42a may be adjusted with respect to the stationary member 44 whereby the tension of the spring 48 may be varied. The hand wheel 45 serves as a means whereby movement of the bearing 42 may be obtained, an indicator gauge or scale 45a being provided on the hub of the hand wheel 45 for accomplishing such adjustment. A lock nut 45b may be provided for the hand wheel 45.

Shafts 40-41 are arranged rollers 49-50 the roller 49 being mounted in suitable bearings and being backed by rollers 51, and these rollers 49-50 are spaced for a substantial distance from the feed rollers 46-47. Bracket members 52 (see particularly Figures 12 and 14) are arranged adjacent the ends of roller 50 and are pivotally supported upon the shaft of such rollers, and connected to the respective brackets by one end are links 53, as at 54 (see Figure 10). The other ends of the links are respectively connected, as at 55, to another bracket 56 that is mounted and keyed to a shaft 57, the latter being supported in suitable bearings preferably by the frame 20 of the machine.

Rotatably mounted preferably upon the shafts of the roller 49 is another bracket 58 which has connected to it one end of a link 59, as at 60. The other end of the link is pivotally connected, as at 61, to a member 52 that is slidably supported in the bracket 56 for adjustment by means of a screw 62.

These connecting links 53-59 and the bracket members 52-56-58 are arranged adjacent the side walls of the machine, the brackets 52 and 56 being disposed respectively adjacent the ends of the rollers 49-50 and 41-42.

Keyed to the shaft 57 is a crank 64 with one arm 65 preferably located in the center of the shaft 57 so that when the shaft 57 is rocked the brackets 52-55 will be rocked about their respective pivots, for a purpose to be described, and this shaft 57 may be rocked in any suitable manner preferably by means of the arm 65 of the crank and to which arm 65 a link 67 is pivotally connected at one end, as at 68. The other end of the link 67 is pivotally connected, as at 69, to a piston rod 70 that in turn is connected to a piston 71 that is removable in a cylinder 72 supported preferably by the frame of the machine.

Fluid pressure is admitted into the cylinder 72 alternately on the opposite sides of the piston 71, in a manner hereinafter to be described, for causing the shaft 57 to be rocked and the brackets or members 52-58 swung about their pivots.

The pinch rollers 49-50 co-operate with the feed rollers 40-41 for causing the material 26 to be fed through the machine and co-operating with these rollers and spaced from each other are additional rollers 13-14 which are of comparatively small diameters with relation to the diameters of the rollers 40-41 and 49-50. The roller 13 is carried by the bracket 58 and is bodily movable therewith, while the roller 14 is carried by the bracket 52 and is bodily movable therewith, so that when the brackets 52-58 are swung...
about their pivots the rollers 73-74 will be bodily moved in opposite directions so as to separate them or move them into positions with respect to each other so as to permit of the feeding of material between the co-operating rollers 40-41 and 49-50.

The rollers 73-74 are respectively backed by rollers 75-76 respectively carried by the brackets 80-82 and these rollers 75-76 are of a comparatively large diameter with respect to the diameters of the rollers 73-74 and abut the peripheries thereof so as to prevent the rollers 72-74 from flexing or springing under pressure.

The rollers 72-74 are adapted to be moved out of alignment with each other by rocking the respective supporting brackets 80-82 and in such position there will be no obstruction for the material to pass directly from between the rollers 40-41 and between the rollers 49-50. When, however, the parts are moved to the position shown in Figures 7 and 9 the rollers 72-74 will engage and flex the material in Figure 7 so that the flexing being effected first in one direction and then in the opposite direction.

The rollers 72-74 being of a smaller diameter with respect to the diameter of the rollers 78-79, the smaller rollers will be prevented from being pulled out of position by the material as it is passing over the rollers, and the backing rollers 75-76 will keep the smaller rollers 72-74 from being deflected so that the sheet of material will be evenly stretched or flexed throughout the entire width of the material and maintain the sheet of material from assuming an undesired flexed or set position.

The rollers 48-50 constitute pinch rollers for gripping the material and for assisting in drawing the material into the machine.

The roller 50 is journaled, as at 77 (see particularly Figures 5 and 7) in bearings carried by a slide 78 that is mounted upon the frame of the machine and this slide carries backings rollers 75, any number of which may be provided, and which are rotatably supported in the slide 78 so as to engage the periphery of the roller 50 and these rollers 75 co-operate with the roller 51 that contact the pinch roller 48 and are rotatably supported upon the frame 29.

The rollers 48 and 79 serve to prevent the pinch rollers 48-50 from being flexed.

As the material 28 passes between the rollers 48-50, the roller 50 together with the slide 78 will be elevated and in order to accomplish this result and at the same time provide pressure on the sheet for the slide 78 and roller 50, there is provided toggle mechanism on each end of the slide 78. This toggle mechanism embodies a link 58 pivotally connected at one end, as at 51, to the slide 78. Another link 53 is pivotally connected at one end, as at 54, to the link 50 intermediate the ends of the latter. The links 55 are connected at one end, as at 56, to the other end of the respective links 55, and are connected at 57 at their other end to a piston rod 59 that slides through the end of the slide frame 29 carried by the sliding frame 78.

Connected to the piston rod is a piston 90 which operates in a cylinder 91, the cylinder receiving fluid under pressure from any suitable source through a pipe 82, in which pipe is provided a fluid pressure regulating valve 93 of any desired or suitable well known construction.

It will therefore be seen that when pressure is admitted into the cylinder 91 and the roller 59 is elevated with respect to the roller 49, the frame 78 will move upwardly, the toggle levers operating to effect a movement of the pistons 90 in the cylinder 91 against the fluid pressure therein. This fluid pressure however, will assist in holding the roller 50 in proper working position and with sufficient pressure to grip or pinch the sheet of material passing between the rollers 49-50.

The adjustment of the roller 50 with respect to the roller 49 may be controlled in any suitable manner but preferably by means of a rod or member 94 which is threaded, as at 95, into the frame 78 and passes through the stationary member 20 of the frame. The free end of the rod or member 94 is threaded, as at 98, onto which a nut or hand wheel 97 is threaded, and which hand wheel when operated will raise or lower the roller 50 and frame 78 with respect to the roller 49. A lock nut 99 may also be provided on the end of the rod member 94.

The severe flexing of the sheet is produced by the two rollers 73-74 which are of small diameter and such flexing occurs between the feed rollers 48-49 and the pinch rollers 49-50. Before the sheet is fed between the feed rollers 48-49 the rollers 73-74 are in an elevated position one above and one below the normal path of movement of the sheet from the rollers 48-49 to the rollers 49-50 and will remain in this position until the sheet passes between the rollers 49-50. Just as soon as the sheet passes between the rollers 49-50 the roller 50 will be elevated with respect to the roller 49, by the material, and this will cause a switch 99 to be operated by reason of a member 100 mounted upon the slide 78 for movement with the other member 100 contacts and operates the switch 99 an electric circuit will be closed through conductors 101-102 (see particularly Figures 7 and 9). The closing of this circuit will energise a solenoid 103 which through the medium of a lever or member 104 operates a four way valve 105 and this valve may be of any ordinary and well known construction, suffice it to say that when the valve is in a position to admit fluid pressure to the cylinder 72 through a pipe 106, any suitable source of fluid pressure supply, the fluid pressure will flow through the pipe 106, through the valve, thence through a pipe 107, into the cylinder 72. At the same time the valve 105 will be set to open communication from the cylinder 72 on the other side of the piston 74 out of the outlet 108 through a pipe 109, thence through the valve and through a discharge pipe 110. In the pipe 106 may be arranged any suitable form of pressure regulating valve 111, a fluid pressure gauge 112, and a globe valve 113.

With the valve 105 in a position to admit fluid pressure from the pipe 106 to the cylinder 72, the piston 71 will move forwardly to the position shown in Figures 7 and 9, causing the flexing rollers 73-74 to assume the position shown in Figure 9 and thereby flexing the material 28 between the feed rollers 48-49 and the pinch rollers 49-50. As the piston 71 moves forwardly fluid on the other side of the piston will be exhausted through the outlet 108.

After the rear end of the sheet has passed from between pinch rollers 49-50 the roller 50 will be lowered until it contacts the roller 49 or stopped by the aforesaid adjusting means, and this will cause the member 100 on the slide 78 to move away from the switch 99 thereby open-
ing the circuit through the conductors 101—102, de-energizing the solenoid 103 and the valve 105 will be positioned so as to connect the pipe 106 with the pipe 109 and the pipe 107 with the exhaust 110 so that the fluid pressure will be admitted to the cylinder 72 on the other side of the piston 71 to separate the flexing rollers 73—74 to permit the insertion of a new sheet so that it will be gripped by the pinch rollers 49—50, during which operation the fluid pressure on the initial side of the piston 71 will be exhausted through the pipe 107 so that the piston will move backwardly to permit such operation or positioning of the flexing rollers 73—74.

The roller 40 of the feed rollers constitutes the driving roller for feeding the sheet therebetween and this roller 40 is positively driven in a manner to be hereinafter described. The drive for this roller 40 (see particularly Figures 2, 4, 11, 13 and 18) embodies the gear 37 loosely mounted upon the shaft of the roller 40 in a suitable bearing 116 which is in turn located in the hub of the clutch member 117 which is mounted for rotation with the clutch member 116 and for adjustment with respect thereto in a direction lengthwise of the axis of the clutch member 117. This is accomplished in any suitable manner preferably by means of ribs 118 on the hub of the clutch member 116 which enter grooves 119 in the clutch member 117.

Supported by the gear 37 is a friction creating element 120 that is adjustably laterally with respect to the gear by means of a tongue and groove connection 121 between the friction element 120 and a portion of the body of the gear 37.

This friction creating element is disposed between the clutch elements 116—117 and co-operates therewith to be gripped by the clutch members so as to lock the gear 37 for rotation with the shaft 40 when the clutch members are moved together, but when the clutch members are separated, the gear 37 may be rotated independently of the roller 40.

Supported by the casing 115 is a cylinder 122 in which is arranged a piston 123 that has contact preferably through a ball bearing 124 with the cylinder 122 such that fluid pressure is admitted through a pipe 125 into the cylinder 122 to force the clutch member 117 toward the clutch member 116 to grip the friction element 120 and thereby lock the gear 37 to the shaft of the roller 40 to cause the latter to rotate when the gears rotate. This movement of the piston 123, however, is effected in opposition to a spring 125, the latter operating when fluid pressure is admitted into the cylinder 122 backwardly so as to unlock the gear 114 from the shaft of the roller 40, thereby permitting free wheeling of the driving roller 40 so that an extra amount of material can be drawn in between the pairs of rollers 40—41 and 45—50 by the engagement of the flexing rollers 73—74 with the material and by the operation of the severe flexing of the material in the space between the feed rollers 40—41 and the pinch rollers 49—50.

The gear 37 which drives the roller 40 will be unlocked with respect to this roller until the end of the material passes from between the pinch rollers 49—50 wherein through the solenoid 103 to operate the feed roller 40 so that the fluid pressure to enter the cylinder 122 to move the piston 123 forwardly and thereby lock the gear 37 in driving relation with respect to the feed roller 40.

At this time the flexing rollers 73—74 will have been separated and the machine will then be in condition for a new sheet to be fed by the feed rollers 40—41 to the pinch rollers 49—50. After the sheet passes from between the pinch rollers 49—50 it is fed into a sheet leveling unit which
consists of a series of superposed rollers arranged in staggered relation with respect to each other. In the present form of the invention one more roller is shown in the lower series 127 than is shown in the upper series 128. The lower series 127 are journaled in suitable bearings 126 (see particularly Figure 6) mounted upon the frame 20 and arranged beneath these rollers and contacting therewith are a series of shorter rollers 130 mounted to freely rotate in bearings 131 supported by the frame 20 and these rollers 130 are provided for the purpose of preventing flexing of the rollers 127. The upper rollers 128 are journaled in suitable bearings 121 mounted upon an adjustable frame 133 carried by this frame 15 are a series of rollers 134 similar to the rollers 130, and are journaled in suitable bearings 135 carried by the frame 133. These rollers 134 contact or back up the rollers 128 and serve as a means for preventing flexing of the rollers under the pressure to which the rollers are subjected.

The frame 133 is provided with trunnions 136 at the opposite ends thereof adjacent the entrance end of the work to the rollers 127—128, and similar trunnions 187 at the opposite ends and adjacent the leaving end of the rollers 127—128.

The trunnions 136 are mounted in slidably adjusted bearings 133 connected to each of which bearings and extending theretofore and through a portion of the stationary frame 20 is a rod or member 130 having a worm gear housed within a casing 140, and engaging with each of said worm gears is a worm carried by a shaft 141 and to which shaft is connected a suitable operating handle 142 so that by operation of the handle 142 and rotation of the shaft 141, the sliding member or unit 133 will be raised or lowered with respect to the lower series of rollers. Each of the trunnions 137 is journaled in an eccentric 143 carried by a bearing 144 and these bearings are slidably mounted upon the frame 20 and may be raised or lowered in any suitable manner, shown by a rod 145 secured to each of them, and passing through a portion of the frame 20.

Carried by the rods and within housings 146 are worm wheels which with worms on a shaft 147 mesh. This shaft is adapted to be rotated by means of a handle 148.

It will therefore be manifest that with this construction and in order to raise or lower the unit or adjustable frame 133, all that is necessary to do is to operate the handles 142 and 146 on the respective shafts 141 and 147. This will vary the position of the upper set of rollers 128 with respect to the lower set of rollers 127.

It is desirable, however, that the rollers 128 in proximity to the exit or leaving side of the machine be spaced a greater distance from the co-operating rollers which are at the entry side of the unit or which are in proximity to the pinch rollers 40—50, and this distance may be varied according to the thickness of the material.

However, this adjustment so as to cause the rollers 128 to be on an inclined plane, so to speak, with respect to the plane of the rollers 127 is accomplished through the medium of the eccentrics 143 in which the trunnions 137 are journaled.

The trunnions 136 in such an instance will form a pivot for the unit 133 and by simply manipulating the hand wheel 148 the outer end of the unit 133 will be elevated and will turn about the trunnions 136 as pivots.

By reason of the eccentrics 143 it will be manifest that the outer end of the unit 133 may be raised or lowered while the inner end will swing only about the pivot 136.

The rollers in the leveling unit are preferably of a very small diameter so that the sheet will receive considerable flexing in the first part of the unit, whereas the rollers in the latter part of the unit may be employed for the purpose of leveling or straightening the sheet.

All of these rollers are driven through individual universal joints from a drive unit in a manner to be described and by reason of the universal joints the rollers may be adjusted without changing the gear centers.

In order to hold the frame 133 in its lowest position so as to create a sufficient stress against the rollers 127 to cause them to co-operate with the rollers 127 to grip the material, springs 149 may be employed.

On the end of each of the rollers 127—128 is a coupling member 150 (see particularly Figure 15) with which another coupling member 151 co--operates and this coupling member 151 is arranged at the end of a shaft 152. Individual to the shafts 152 is a driving shaft 153 and a coupling member 154 couples the ends of the shafts 152—152 to form a universal joint. This coupling member may be in the form of a sleeve slidably mounted upon one of the shafts and adapted to engage over the end of the other shaft, and a spring 157 holds this sleeve in position.

With this construction it will be manifest that when the shaft 153 is rotated the corresponding roller 127 will be rotated and by reason of the couplings there will be formed an universal joint so that the rollers 127—126 may be relatively and laterally adjusted without changing the centers of the driving shafts 153.

Motion is imparted to the rollers 127 preferably from a motor 158 through the medium of a drive belt 159 to which passes over a pulley 160 on the shaft of the motor and a pulley 161 secured to a shaft 161 mounted in suitable bearings 162 (see particularly Figure 15). Secured to the shaft 161 is a gear 163 which meshes with a gear 164 that is carried by a shaft 165 that is connected to the lower pinch rollers 40—50 of a suitable coupling 156c (see particularly Figures 1 and 5). A gear 162 on the shaft 161 meshes with an idler gear 165 carried by a stub shaft 166. This gear 165 operates all of the rollers 127—128 and in order to cause them to rotate in the same direction, they are driven in groups as shown more clearly in Figure 17.

The gear 165 meshes with a gear 167 that is carried by the shafts 153 of one of the rollers 128, and carried by the shaft 153 is a gear 168 which meshes with gears 175—176—177 and 178 on similar shafts 153 of other rollers so that when the gear 167 is rotated the shafts 153 of one group of five of the rollers will cause all of the rollers of that group to rotate in the same direction.

The gear 167 also meshes with a gear 173 that is carried by another of the shafts 153 of another group of rollers. Carried by the shaft 153 is a gear 174 which meshes with gears 175, 176, 177 and 178 on others of the shaft 153 of the rollers, so that upon rotation of the gear 173 the gear 175 will be rotated and this in turn will rotate the gears 174—175—176—177 and 178. Another group of the rollers 127—128 is similarly rotated through the medium of a gear 178 which is secured to another of the shafts 153 and
meshes with the gear 161. On this latter shaft 156 is a gear 160 which in turn meshes with gears 161—162—163 and 194 on similar shafts 153 of others of the rollers.

Thus when the shaft 161 is rotated, the gear 165 will rotate the gear 167 and this gear in turn will rotate the gears 175—179. The gear 168 being rotated with the gear 163 will through the medium of the interconnecting gears of that group rotate the shafts 169—170—171 and 172.

The rotation of the gear 167 imparting rotation to the gear 179 will rotate the gear 180 and this in turn will rotate the gears 181—182—183 and 184 of that particular group. Likewise, the rotation of the gear 173 by the gear 167 will rotate the gear 174 and through the medium of the interconnecting gears the gears 175—176—177 and 178 will be rotated.

It will therefore be seen that all of the rollers 127—128 will be positively driven and rotated in the same direction. At the same time by reason of the universal couplings or connections between the rollers and their driving gears, the upper set of rollers 125 together with the frame or the 133 may be bodily adjusted toward' and away from the lower set of rollers and the frame 133 may be tilted or raised at one end so that the rollers at the exit end of the unit will be spaced a greater distance than the rollers at the entrance end.

All of these gears which operate the rollers 127—128 may be housed within a casing provided with a closure 105. The motor 150 is supported by a base 158c hinged at one end, as at 186, and having a fastening or securing means at the other end which fastening means may be in the form of a turn buckel 181 having threads for engagement with an element 186 pivotally anchored as at 185, while the other end of the turn buckle has engagement with an element 190 pivotally anchored, as at 191.

It is thought that the operation of this machine will be clearly understood from the foregoing but briefly stated it is as follows:

To set the machine for operation, fluid pressure is admitted into the cylinder 72 ahead of the piston 71 so as to move the latter backwardly in the cylinder 72 and below the lock shaft 57, the movement of which latter through the medium of the bracket 56 and the brackets 52—56 will cause the flexing rollers 73—74 to be separated so that a strip of metal can be conveyed between the cleaning brushes 25 past the washing sprays 38 and into the bite of the rollers 49—41. From there the material is fed directly across to the rollers 49—50 so as to pass therebetween, it of course being understood that the rollers 186 have been adjusted to the proper position with respect to the rollers 127 and preferably so that the rollers at the exit end of the leveling unit will be spaced a greater distance than the rollers at the entrance end.

The material will then be fed forwardly by the feed roller 40 which is positively driven. As soon as the material flexing between the rollers 49—50 the roller 50 will be elevated and this will cause the sliding frame 78 to be raised until the member 100 engages and actuates the switch 95. This switch when actuated will close the circuit of the solenoid 101—102 to energize the solenoid 103. The solenoid becoming active will then actuate or set the valve 105 so as to admit fluid pressure into the cylinder 72 behind the piston 71 to move the latter forwardly to the position shown in Figure 9, and to exert fluid pressure from the other side of the piston.

Upon this movement of the piston 71 the shaft 54 will be rocked in a direction that will lower the flexing rollers 73—74 to the same relative positions in which they are shown in Figures 7 and 9 to deflect or flex the material, considerably and abruptly in the space between the feed rollers 49—50 and the pinch rollers 49—50. The rollers 73—74 being of small diameter will cover a considerable flexing of the material.

Just at about the time the flexing rollers 73—74 contact the material the feed roller 40 is released, that is, the clutch mechanism shown in Figure 18 will cause the gear 114 to be unlocked with respect to the shaft of the roller 46. This will result in freeing the roller 40 for a free wheeling movement so that enough material will be pulled into the space between the feed rollers and the pinch rollers so as to permit the flexing operation by the flexing rollers 73—74.

If the peripheral speed of the rollers 49—50 and the rollers 49—50 were maintained the same during this flexing movement, considerable damage would be done to the material, but the recesses of the feed roller 40 will permit a free wheeling of the latter so that sufficient material will be drawn in or advanced by the flexing rollers 73—74 to permit of such flexing.

From the pinch rollers 49—50 the material which has been previously flexed passes between the sets of rollers 127—128 so as to be leveled or straightened out.

The rollers 127—128 being of small diameter and being in closer proximity to each other at the entrance to the unit than at the exit, the material will be violently flexed and then gradually straightened out as it leaves the unit.

While the preferred form of the invention has been herein shown and described, it is to be understood that various changes may be made in the details of construction and in the combination and arrangement of the several parts, within the scope of the claims, without departing from the spirit of this invention.

What is claimed as new is:

1. A machine for flexing a sheet of material embodying opposed series of rollers for straightening the material, feeding the material to said straightening rollers, opposed flexing rollers in advance of the feeding rollers and between which flexing rollers the material passes to the feeding rollers, said flexing rollers having a fixed operative relation to each other, means whereby such fixed relation may be varied at will, means for moving said flexing rollers across the path of movement of the material to the feeding rollers, and means controlled by the passage of the material between the feeding rollers for controlling the positioning of said flexing rollers.

2. A machine for flexing a sheet of material embodying opposed series of rollers for straightening the material, feeding rollers for feeding the material to said straightening rollers, opposed rollers across the path of movement of the feeding rollers, opposed flexing rollers in advance of the feeding rollers and between which flexing rollers the material passes to the feeding rollers, said flexing rollers having a fixed operative relation with respect to each other, means whereby such fixed relation may be varied at will, means for moving the said flexing rollers across the path of movement of the material to the feeding rollers, and fluid pressure actuated means controlled by the passage of the material between the feeding rollers for controlling the positioning of said flexing rollers.
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rolls and respectively contacting the flexing rolls to maintain them against distortion, means controlled by the passage of the material between the feeding rolls for controlling the positioning of the flexing rolls, and means for effecting relative bodily adjustment of the flexing rolls one with relation to the other.

12. An apparatus of the character described, embodying upper and lower feed rolls, upper and lower pulling rolls spaced from said feed rolls and defining therewith a path of travel for the sheet passing between the rolls, means for driving said rolls, sheet flexing rolls arranged between said feed and pulling rolls, respectively above and below the normal path of travel of the sheet, means for moving said flexing rolls across the path of movement of the sheet on its passage from the feeding to the pulling rolls, said feeding and pulling rolls being disposed in close proximity to each other, said flexing rolls being of comparatively small diameter and being bodily adjustable independently one with relation to the other, means for effecting such bodily adjustment for operation upon the sheet, backing rolls also in the space between the feeding and pulling rolls and respectively contacting the flexing rolls to maintain them against distortion, and means controlled by the passage of the material between the feeding rolls for controlling the positioning of the flexible rolls.

14. An apparatus of the character described, embodying upper and lower feed rolls, upper and lower pulling rolls spaced from said feed rolls and defining therewith a path of travel for the sheet passing between the rolls, means for driving said rolls, sheet flexing rolls arranged between said feed and pulling rolls, respectively above and below the normal path of travel of the sheet, means for moving said flexing rolls across the path of movement of the sheet on its passage from the feeding to the pulling rolls, said feeding and pulling rolls being disposed in close proximity to each other, said flexing rolls being of comparatively small diameter and being bodily adjustable independently one with relation to the other, a rock shaft, a connection between each of said flexing rolls and said rock shaft, whereby upon operation of the rock shaft the said flexing rolls will be bodily positioned to operate upon the sheet, backing rolls also in the space between the feeding and pulling rolls and respectively contacting the flexing rolls to maintain them against distortion, and means controlled by the passage of the material between the feeding rolls for controlling the positioning of the flexing rolls.

15. An apparatus of the character described, embodying upper and lower feed rolls, upper and lower pulling rolls spaced from said feed rolls and defining therewith a path of travel for the sheet passing between the rolls, means for driving said rolls, sheet flexing rolls arranged between said feed and pulling rolls, respectively above and below the normal path of travel of the sheet, means for moving said flexing rolls across the path of movement of the sheet on its passage from the feeding to the pulling rolls, said feeding and pulling rolls being disposed in close proximity to each other, said flexing rolls being of comparatively small diameter, backing rolls engaging the flexing rolls whereby to prevent distortion of the flexing rolls, one of said flexing rolls when operating to deflect the sheet being wedged between its backing roll and one of the feeding rolls, and the other flexing roll being wedged between its backing roll and one of the pulling rolls, whereby the back end of the sheet will when passing between the rolls be held in close proximity to the roll.

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3. A machine for flexing a sheet of material embodying a plurality of series of straightening rollers arranged in staggered relation, a plurality of pairs of feeding rollers in advance of the straightening rollers, said pairs of feeding rollers being spaced apart, means for rotating the feeding rollers, a stretcher roller disposed to operate in the space between said pairs of feeding rollers, means for bodily moving said stretching roller across the path of feeding movement of the material from one pair of feeding rollers to another, and means for releasing one of said feeding rollers with respect to its rotating means whereby the last said roller will be adapted for free rotation while the material is in engagement therewith and while it is being flexed by said flexing rollers and gripped by the other pair of feeding rollers.

4. A machine for flexing a sheet of material embodying a plurality of series of straightening rollers arranged in staggered relation, a plurality of pairs of feeding rollers in advance of the straightening rollers, said pairs of feeding rollers being spaced apart, means for rotating the feeding rollers, a stretcher roller disposed to operate in the space between said pairs of feeding rollers, means for bodily moving said stretching roller across the path of feeding movement of the material from one pair of feeding rollers to the other, means controlled by the passage of the material from one of said pairs of feeding rollers for controlling bodily movement of said stretcher roller, and means for releasing one of said feeding rollers with respect to its rotating means whereby the last said roller will be adapted for free rotation while the material is in engagement therewith and while it is being flexed by said flexing rollers and gripped by the other pair of feeding rollers.

5. A machine for flexing a sheet of material embodying two pairs of co-operating feeding rollers between which the material successively passes, driving means for one of the rollers of each pair, means operable to engage the feeding rollers of said passing material while the latter is passing between both pairs of rollers, and means for releasing one of said rollers from its driving means while the material is in engagement therewith and as the material is being deflected by said deflecting means.

6. A machine for flexing a sheet of material embodying spaced co-operating pairs of rollers between which the sheet is successively fed, a pair of flexing rollers having a fixed operative relation to each other and disposed between said pairs and disposed on opposite sides of said sheet, a movable support for each of said flexing rollers, a rocking shaft, an adjustable and operative connection between each of said supports and said rocking shaft whereby the fixed relation of one of the flexing rollers may be varied with respect to the other, and means for rocking said shaft to cause said flexing rollers to engage the sheet on opposite sides thereof and abruptly bend the sheet in opposite directions, driving means for one of the rollers of each of the first said pairs of co-operating rollers, and means operating in co-ordination with said flexing rollers for rendering the driving means of one of the rollers of said pairs of rollers inactive with respect thereto, whereby the last said roller will be adapted for free rotation as the sheet is deflected and while in engagement with both of said co-operating pairs of rollers.

8. A machine for flexing a sheet of material embodying two pairs of co-operating rollers simultaneously gripping and feeding a sheet successively therewith, means operating between the pairs of rollers for abruptly deflecting the sheet, rotating brushes between which the sheet passes before reaching the said rollers, liquid spraying means disposed between the brushes and the first of said pairs of rollers, and means for causing the rollers of one of said pairs to have a free wheeling movement at the time when the sheet is being deflected in the space between the said two pairs of rollers.

9. A machine for flexing a sheet of material embodying two pairs of co-operating rollers simultaneously gripping and feeding a sheet successively therewith, means operating between the pairs of rollers for abruptly deflecting the sheet, and means for causing the rollers of one of said pairs to have a free wheeling movement while the sheet is in contact therewith and at the time when the sheet is being deflected in the space between the said two pairs of rollers.

10. An apparatus of the character described, embodying upper and lower feed rolls, upper and lower pulling rolls spaced from said feed rolls and defining therebetween a path of travel for the sheet passing between the rolls, means for driving said rolls, sheet flexing rolls arranged between said feed and pulling rolls, respectively above and below the normal path of travel of the sheet, means for moving said flexing rolls across the path of movement of the sheet on its passage from the feeding to the pulling rolls, said feeding and pulling rolls being disposed in close proximity to each other, said flexing rolls having of comparatively small diameter and being bodily adjustable independently one with relation to the other, means for effecting such bodily adjustment for operation upon the sheet, backing rolls also in the space between the feeding and pulling rolls and respectively contacting the flexing rolls to maintain them against distortion, and means controlled by the passage of the material between the feeding rolls for controlling the positioning of the flexing rolls.

11. An apparatus of the character described, embodying upper and lower feed rolls, upper and lower pulling rolls spaced from said feed rolls and defining therebetween a path of travel for the sheet passing between the rolls, means for driving said rolls, sheet flexing rolls arranged between said feed and pulling rolls, respectively above and below the normal path of travel of the sheet, means for moving said flexing rolls across the path of movement of the sheet on its passage from the feeding to the pulling rolls, said feeding and pulling rolls being disposed in close proximity to each other, said flexing rolls having of comparatively small diameter and being bodily adjustable independently one with relation to the other, means for effecting such bodily adjustment for operation upon the sheet, backing rolls also in the space between the feeding and pulling