April 5, 1932. F. C. AREY 1,852,636

MACHINE FOR EXPANDING RIBBED METAL LATH

Filed Aug. 8, 1927 6 Sheets-Sheet 1

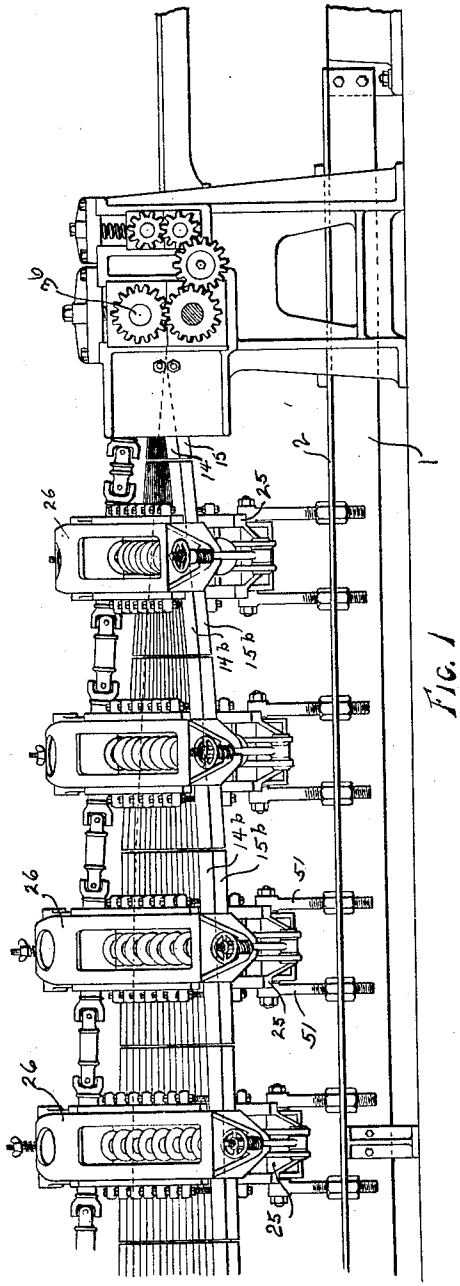

FIG. 1

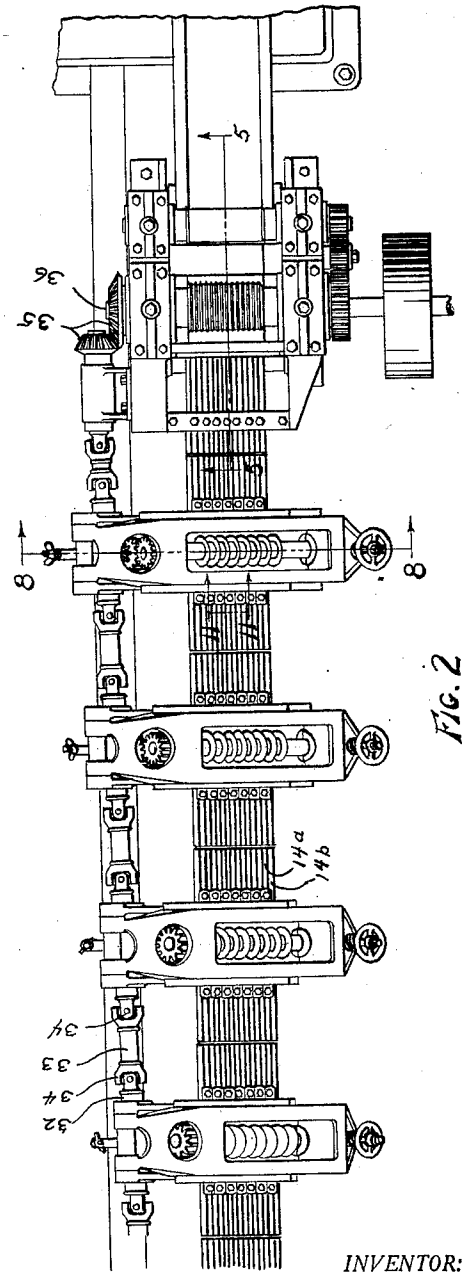

FIG. 2

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Filed Aug. 8, 1927 6 Sheets-Sheet 2

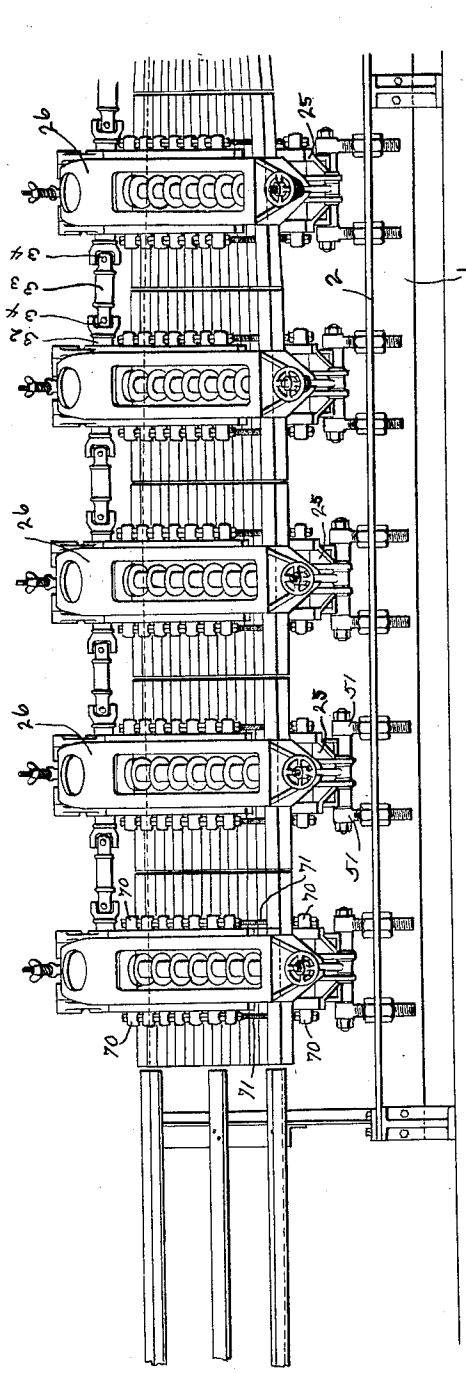

FIG. 3

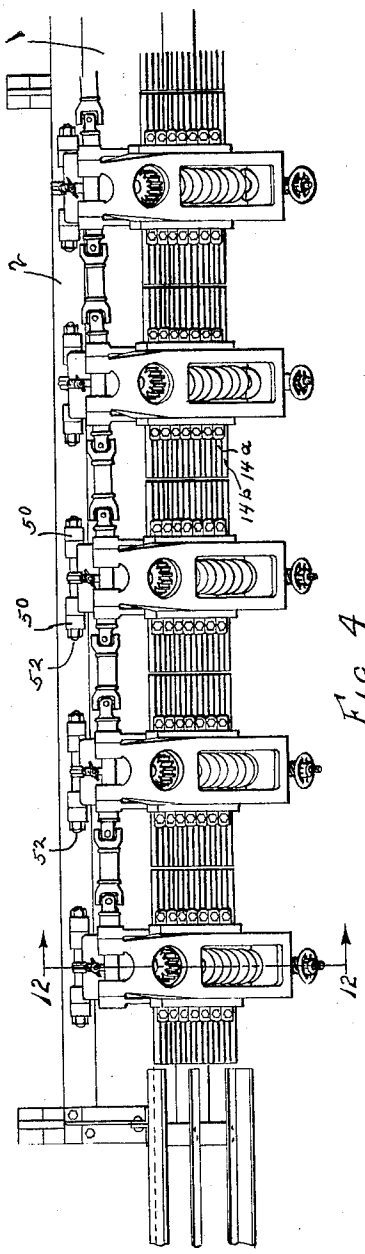

FIG. 4

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MACHINE FOR EXPANDING RIBBED METAL LATH

Filed Aug. 8, 1927 6 Sheets-Sheet 3

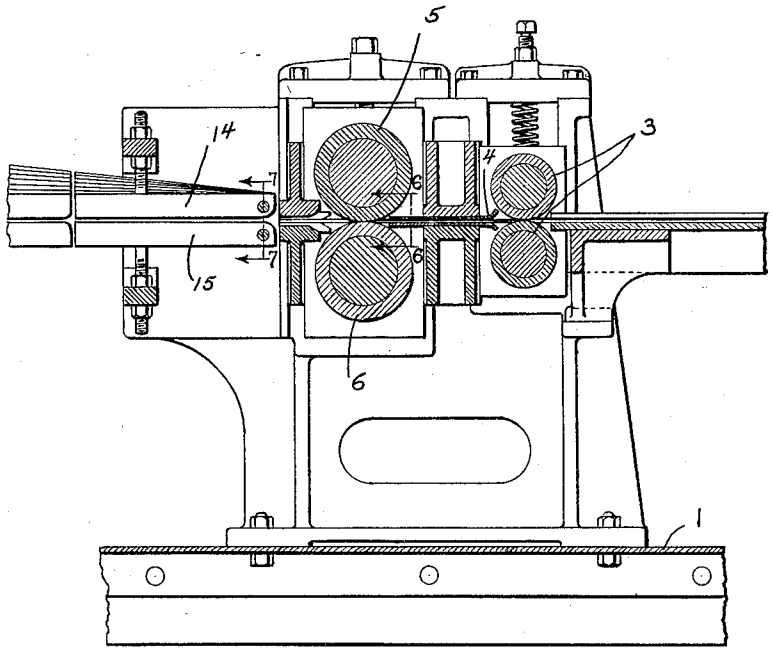

FIG. 5

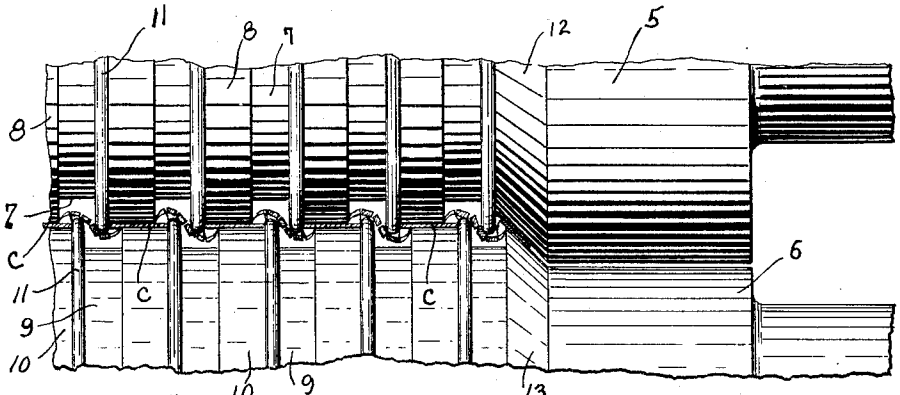

FIG. 6

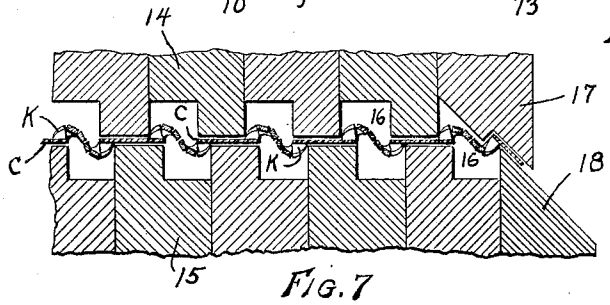

FIG. 7

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MACHINE FOR EXPANDING RIBBED METAL LATH

Filed Aug. 8, 1927 6 Sheets-Sheet 4

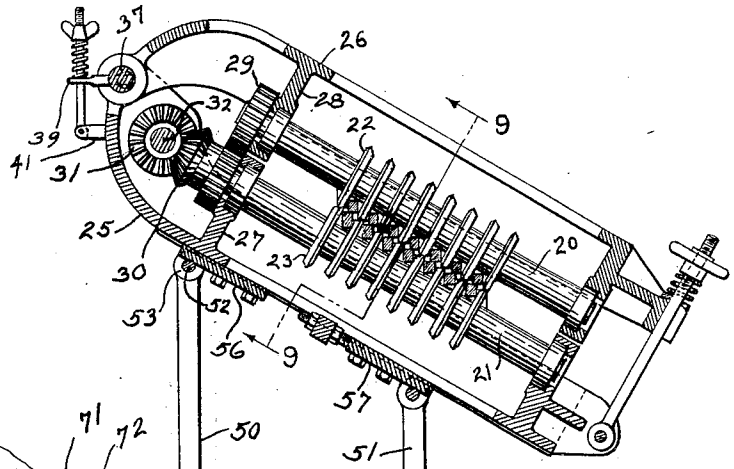

FIG. 8

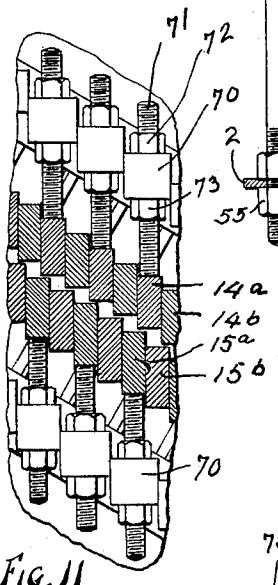

FIG. 11

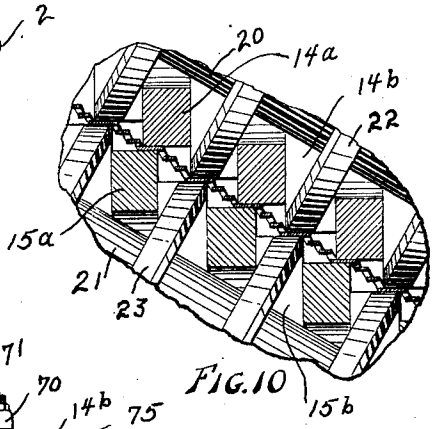

FIG. 10

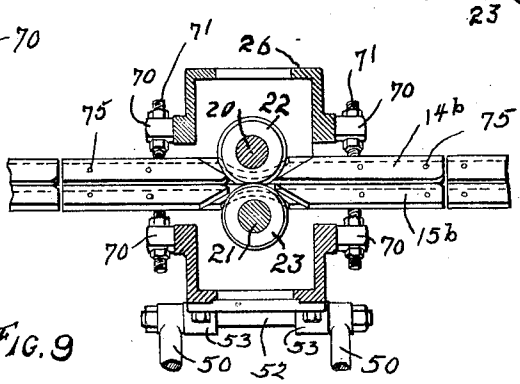

FIG. 9

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MACHINE FOR EXPANDING RIBBED METAL LATH

Filed Aug. 8, 1927 6 Sheets-Sheet 5

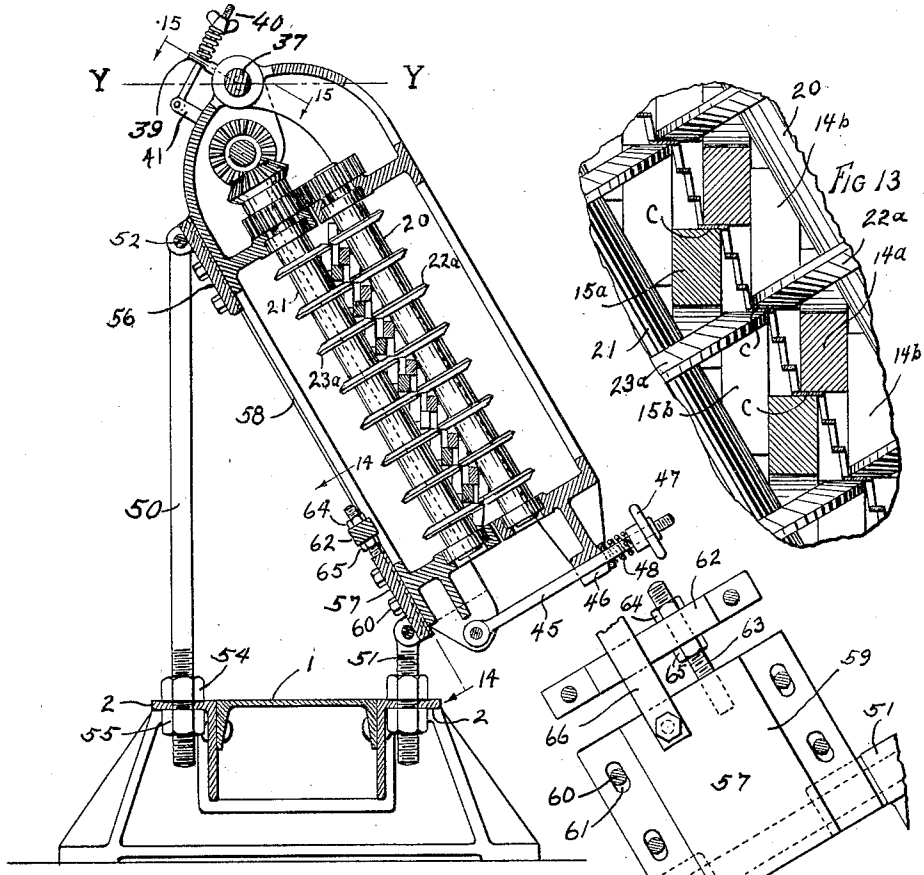

FIG. 12

FIG 13

FIG. 14

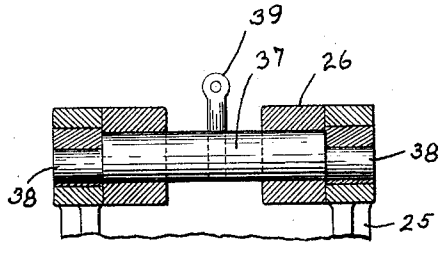

FIG. 15

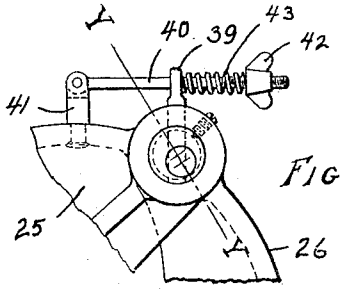

FIG 16

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MACHINE FOR EXPANDING RIBBED METAL LATH

Filed Aug. 8, 1927 6 Sheets-Sheet 6

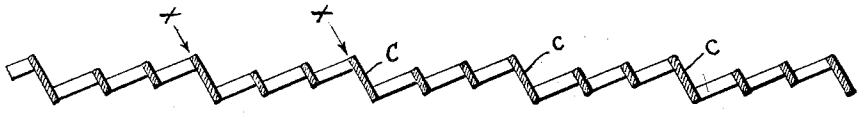

FIG. 18

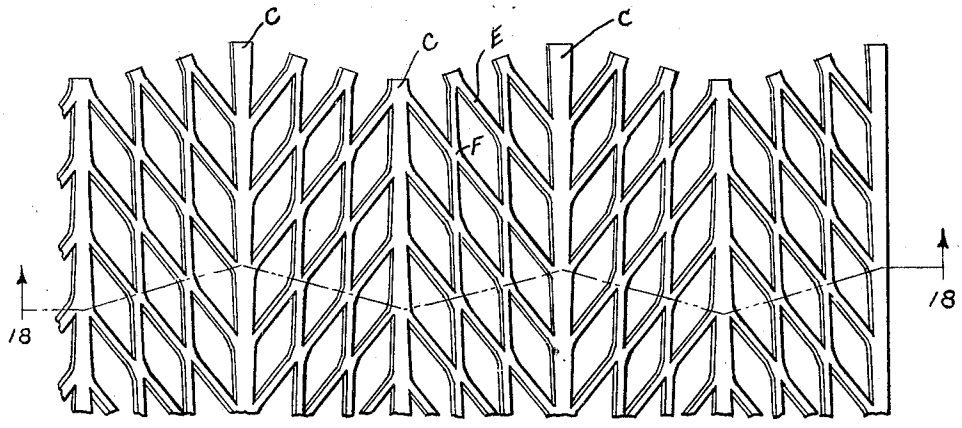

FIG. 17

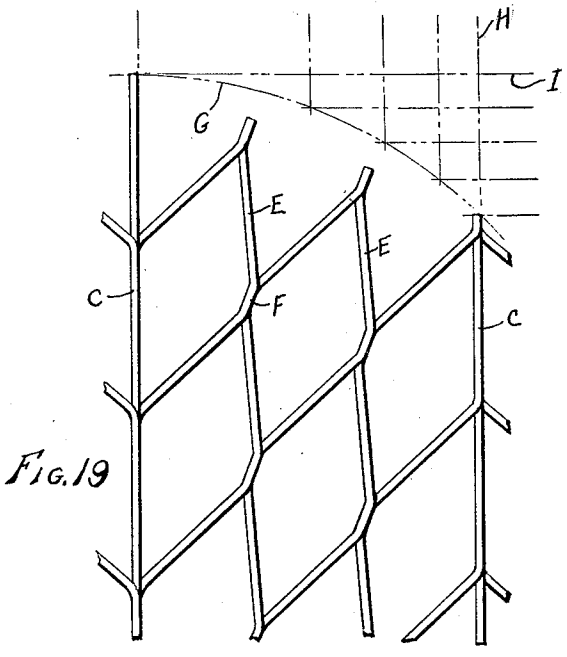

FIG. 19

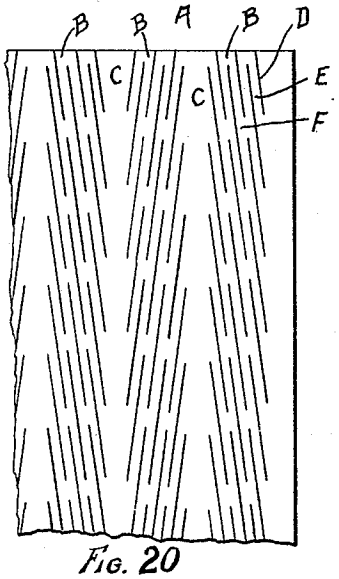

FIG. 20

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Patented Apr. 5, 1932

1,852,636

UNITED STATES PATENT OFFICE

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MACHINE FOR EXPANDING RIBBED METAL LATH

Application filed August 8, 1927. Serial No. 211,309.

The present invention has for its object to expand a metal sheet consisting of slitted portions alternating with unslitted rib-forming portions in such a manner that a uniform tension will be maintained throughout all of the strands during the expanding process.

A further object of the present invention is to produce a simple novel and efficient machine for producing the expansion of a sheet in the manner just described.

A further object of the present invention is to expand a sheet consisting of diagonally slitted panels alternating with unslitted rib-forming sections, that the latter sections will at no time assume or be caused to assume a twist, although being permitted to move relatively to each other in the lengthwise direction while the strands are being opened and thus relieve the strands from unnecessary stresses.

The product produced in the preferred form of my machine is one in which the ribs or unslitted portions lie at an acute angle to the general plane of the sheet. The old practice in producing a sheet of this kind involved various distortions of the metal, such as twisting the ribs or corrugating them, that weakened the same and required the expenditure of unnecessary energy; the result being an inferior product made at too high a cost. One of the objects of the present invention is to produce a machine which will impose on the slitted sheet no other stresses than those required to expand the slotted areas.

In the preferred means whereby my invention is carried out, I provide long guides whose working faces at one end are all in the same plane and which are gradually spread in a manner comparable to bending the same in planes at right angles to the aforesaid plane, together with feed rolls cooperating with the working faces of the guides to draw the unslitted sections or ribs of a sheet along the guides while the slitted sections of the sheet are gradually expanded. One of the objects of the present invention is so to dispose the guides and the feed rolls that the lengthwise movements of the unslitted sections or ribs are at all times such as to permit the strands to swing naturally into their opened positions, without imposing on the strands stresses other than those required to swing them in directions to produce the desired mesh.

In the slitting of a sheet as a preliminary step to the expansion of the same, the slits are produced by pressing portions of each element that is to constitute a strand in the finished product out of its normal plane. Therefore since the body of a sheet remains unchanged, this distortion of the strand portions can be brought about only by a stretching or lengthening of such portions. A further object of the present invention is so to expand a sheet that what may be termed the slack due to the stretched strand portions is first taken up at the advance end of the sheet before the actual expansion begins.

In the expanding of a slitted sheet by a continuous process, the expansion of one end of the sheet is completed while a considerable amount of expansion is yet to take place at the rear end. A further object of the present invention is so to manipulate a slitted sheet that the slack due to the stretching of the strand portions in the slitting operation is completed at the advance end of the sheet as a preliminary step, whereas the slack at the trailing end of the sheet is taken up as the final step in the expanding operation.

A further object of the present invention is to produce a machine which may be said to be arranged in halves between which the sheet that is being expanded lies at all times, and arranging one of the halves in such a way that any section thereof may readily be moved into a position that will give full and easy access to the work underlying the same.

A further object of the present invention is to produce an expanding machine that will yield under an abnormal thickness of metal passing through the same, without imposing objectionable stresses on the parts of the machine, and which will at all times adjust itself automatically to the thickness of the work.

A further object of the present invention is to produce an expanding machine comprising guides and cooperating feed rolls, the latter being arranged at varying angles, in

which the rolls and the guides can be quickly and easily adjusted in any direction.

The various features of novelty whereby my invention is characterized will hereinafter be pointed out with particularity in the claims; but, for a full understanding of my invention and of its objects and advantages, reference may be had to the following detailed description taken in connection with the accompanying drawings, wherein:

Figure 1 is a side elevation of the receiving end of a machine embodying the present invention; Fig. 2 is a top plan view of that portion of the machine shown in Fig. 1; Fig. 3 is a view similar to Fig. 1, illustrating the delivery end of the machine; Fig. 4 is a plan view of the delivery end of the machine; Fig. 5 is a central longitudinal section, on a larger scale than Figs. 1 to 4 through the receiving end of the machine, namely on line 5—5 of Fig. 2; Fig. 6 is a section taken approximately on the line 6—6 of Fig. 5, showing fragments of the initial deforming feed rolls and a sheet lying between the same; Fig. 7 is a section taken approximately on line 7—7 of Fig. 5, the scale being the same as that of Fig. 6, and only fragments of a portion of the guide bars being shown; Fig. 8 is a section taken approximately on line 8—8 of Fig. 2 on a somewhat larger scale than Fig. 2; Fig. 9 is a section taken on line 9—9 of Fig. 8; Fig. 10 is a view similar to Fig. 8, on a larger scale, and showing only a fragment of the two feed rollers and guides; Fig. 11 is a section taken approximately on line 11—11 of Fig. 2 being on a smaller scale than Fig. 10; Fig. 12 is a section taken on line 12—12 of Fig. 4, being a view similar to Fig. 8 and being on the same scale; Fig. 13 is a view similar to Fig. 12 but on a larger scale, showing only a fragment of the machine; Fig. 14 is a section taken approximately on line 14—14 of Fig. 12; Fig. 15 is a section, on an enlarged scale, taken approximately on line 15—15 of Fig. 12; Fig. 16 is a side view of the parts partially shown in Fig. 16; Fig. 17 is a plan view of the expanded product; Fig. 18 is a section taken approximately on line 18—18 of Fig. 17; Fig. 19 is a view looking in the direction of the arrows X in Fig. 18, together with a diagram illustrating the manner of expanding the sheet and Fig. 20 is a plan view of a fragment of the slitted sheet or blank.

Referring to Fig. 20 of the drawings, A represents a metal sheet divided into slitted sections B and unslitted sections C alternating with the slitted sections. The slits D are arranged at an acute angle to the long edges of the sheet in the form of broken lines, the unslitted portion in each line lying opposite slitted portions in the two adjacent lines; each slitted panel or section being therefore made up of rudimentary strands E and bonds F. When the sheet is expanded it has the appearance shown in Figs. 17 and 18, the unslitted portion C constituting longitudinal ribs and the strands E forming diamond mesh in the spaces between the ribs. A slitted panel may be expanded by the simple process of holding an adjacent unslitted section stationary and pulling the other adjacent unslitted section out of its normal plane; this action simply bending the strands at both ends, namely where they join the ribs and where they join the bonds; thus imposing on the strands only such stresses as are necessary to overcome the resistance to bending. During such expanding operation the rib that is being moved to produce the expansion must move lengthwise to accommodate itself to the new positions of the strands intervening between it and the other rib. The composite movement of a point in the travelling unslitted section or rib is indicated by the dotted line G in Fig. 19; the progress of this point transversely and lengthwise being illustrated by the vertical and horizontal dotted lines H and I. It will be seen that the lateral movement of the rib for a given lengthwise movement gradually decreases. In the slitting of the sheets, since the cutters must pass through the same, the rudimentary strands will be bowed out of the plane of the sheet, thus being stretched and lengthened. During the first part of the expanding action of the sheet, these strands should be straightened. It will be seen from the curve G that at the start the theoretical lengthwise movement of the travelling rib is very small. Therefore, as the strands are straightened at the beginning of the expanding operation, their increased length produces an offset to their angular movements, so that the travelling rib will not begin to move lengthwise until what may be termed the slack in the strands may be taken up.

In actual practice the sheet will be progressively expanded from one end toward the other, and my invention contemplates such a manipulation of the sheet that the various shifting elements in the same will be permitted to follow their natural courses while the strands are subjected to uniform tension at all times.

All of the mechanisms constituting my improved machine may be mounted on a suitable long narrow base 1 conveniently having outwardly projecting horizontal flanges 2 along the top. The slitted sheet is fed lengthwise between the pair of horizontal feed rolls 3, through a suitable guide 4 and to a second pair of horizontal feed rolls 5 and 6, best shown in Fig. 5. The rolls 3 may be simple cylindrical members, but the rolls 5 and 6 are shaped to deform the sheet so as to produce the bends at the juncture of the strands with the rib sections, or at least cause the beginning of such bends. The construction of these rolls and their effect upon the work is shown in Fig. 6. It will be seen that each

roll consists of sections of one diameter alternating with sections of a larger diameter; these sections in the roll 5 being indicated at 7 and 8 and in the roll 6 at 9 and 10. Calling the sections of large diameter collars and the peripheral spaces between the collars grooves, it will be seen that each collar engages with a collar on the opposed roll and overhangs a groove in the latter roll. Each collar has on one side an annular flange or rib 11; those on one roll being on the left hand side of the collars and those on the other roll being on the right hand side of the collars. The parts are so proportioned that when the prepared sheet is fed between the rolls 5 and 6 the rib sections C are gripped between the collars while the slitted sections are drawn over the beads or flanges so as in cross-section to have the appearance of a flattened **S**. Thus are formed bends K, as best shown in Fig. 7, at the points where the strands join the ribs. The ends of the rolls, or rather those sections that may be said to constitute the endmost collars, are preferably made in the form of frustums of cones, as indicated at 12 and 13, so as to bend the marginal rib sections downwardly at an angle to the plane of the sheet and insure that the sheet will be gripped tightly enough along the side marginal portions to prevent the side edges from being drawn in toward the center.

When the sheet emerges from the rolls 5 and 6 it is ready to pass to the expanding guides for the purpose of being expanded. These guides are in the form of bars arranged in pairs, one above the other, there being as many pairs as there are rib sections in the sheet; these bars expanding from one end of the machine to the other without twisting of any kind; the central pair of bars being straight and those on each side thereof being gradually curved upward in the upward half and downward in the lower half so as to produce a fan-shaped arrangement. For the sake of convenience in manufacture, adjustment, inspection and removal of damaged sheets, the bars are preferably made in short sections arranged end to end, instead of being continuous. The guide bars begin a short distance from the rolls 5 and 6, the various upper sections being indicated at 14 and the various lower sections at 15. The working faces of all of the upper bars are in the same horizontal plane at the receiving end, while the upper or working faces of the lower bars at this point are also in the same horizontal plane. The bars of each pair do not register completely but, as best shown in Fig. 7, less than one-half of each upper bar overlies a corresponding portion of the companion lower bar. Furthermore, about one-half of the working face of each bar is cut away to a considerable depth, so as to provide between each pair of bars a chamber 16 that will receive the slitted sections of the sheet while the ribs lie between the effective working faces. The bars at each side of the group as a whole have their working faces in the form of inclined planes, two of these bars being indicated at 17 and 18 in Fig. 7; thus making provision for receiving the flanged side marginal portions of the sheet. The guide bars, as heretofore explained, while forming a composite structure of uniform width as viewed from below are disposed in fan-shape. At a short distance from the feed rolls 5 and 6 is a feed roll unit shown in detail in Figs. 8, 9 and 10. This feed roll unit consists of two parallel shafts 20 and 21 lying at the same angle as the guide bars at this point. On the shafts are suitable cooperating collars 22 and 23, there being half as many collars on each shaft as there are pairs of guide bars, and the collars being spaced apart between centers a distance equal to twice the distance between centers of adjacent guide bars. While the guide bars were required to have pecularly shaped working faces at the receiving end of the bars, for the purpose of providing spaces to receive the slitted sections of the sheet, they may now be simple bars rectangular in cross-section. Alternate pairs of these bars, indicated at 14*a* and 15*a*, pass continuously between the rolls 20 and 21 through the spaces bounded at the sides by the collars. The remaining pairs of bars 14*b* and 15*b* are in line with the collars and must therefore be interrupted at the collars. Therefore the sheet is gripped between the collars on these feed rollers at every other rib, the remaining ribs simply sliding between the guides that are not interrupted at the feed rolls. It will be seen in Fig. 20 that the slits in alternate slitted sections are inclined oppositely. Therefore if alternate ribs are gripped and held stationary with respect to each other during the expansion, the remaining ribs will all swing in the same direction and to the same extent with respect thereto. In other words, if the left hand rib in Fig. 19 be the stationary rib, then another rib to the left of the same will swing downwardly during the expansion process in the same way as does the rib shown at the right in this figure or, if two ribs having between them another rib are held against lengthwise movement during lateral expansion, the central rib will be compelled to move lengthwise during such expansion. This is what occurs at the feed rolls; two of the ribs in the sheet being gripped and driven ahead at a uniform speed, while an intermediate rib simply slides freely along its guides and may therefore lag behind as the strands between it and the two flanking ribs continue to open.

It will be seen that the spreading of the guide bars in a fan-shaped arrangement, by extending the bars gradually out of the plane

in which their advance ends lie, without twisting, causes the effective width of the guide structure, measured along a transverse line in contact with the work, to increase gradually. In other words, the central rib proceeds in a straight line while the ribs on each side are gradually bent up or down, depending on which side of the center they lie; those closest to the center being bent the least and each rib being bent to a degree proportionate to its position in the sheet relative to the central rib.

Throughout the length of the machine are located many other feed roller units similar to the one just described with the exception that the shafts are longer, the collars spaced farther apart and the inclination is different. Thus, for example, in Figures 12 and 13 there is shown one of the final feed roller units consisting of shafts 20 and 21 and collars 22^a and 23^a. It will be seen that while the first feed roller unit, illustrated in Fig. 8, is very nearly horizontal, the final units are almost as nearly vertical.

The last group of feed roller units are all alike and all placed at the same angle, since their purpose is to hold the finished portion of of sheet while the expansion of the trailing end is being completed.

The inclination of the feed roll units depends of course upon the degree to which the upward and downward bends in the guide bars have been made at the points where the feed roll units occur, namely upon the width of the partially expanded sheet at these points. It will be seen that the expansion takes place progressively from the front end of the sheet toward the rear, so that at the time the front end of the sheet has been expanded to its full width the rear end is not yet fully expanded. Therefore the rate of relative longitudinal movement of the so-called free ribs, because of the condition illustrated in Fig. 19, is variable throughout the length of the sheet, being greater at the advance end than at the trailing end. For this reason, while the guides must be continuously inclined during the expanding zone of the machine, the rate of inclination must become gradually less and therefore, while the feed roll units are all displaced angularly in the same direction from each other from the inlet end toward the outlet end of the expanding zone, the angular displacement between consecutive feed roll units decreases gradually throughout the expanding zone. Furthermore, after all of the so-called slack has been taken up in the advance end of a sheet and the actual expansion begins, this expanding action is carried back through the length of the sheet before all of the slack is taken up at the rear end and consequently the final operation on the sheet at the rear end is the taking up of the slack due to the slight stretching incident to the slitting operation.

When the sheet first enters the guides in the machine, as shown in Fig. 7, the expanding pull is parallel to the plane of the sheet and it is for this reason that the inclined side guides 17 and 18 are required to grip the side marginal portions of the sheet while the S-shaped expanded sections are being straightened. By the time that the sheet reaches the first feed roller unit, as illustrated in Figs. 8 and 10, the expanding pull is at a considerable angle to the plane of the flat faces of the ribs and the special gripping guides along the side marginal portions are no longer required because the necessary resistance to the component of the pulling force parallel to the plane of the sheet is afforded by the strands in the expanded portions abutting against the sides of the guides and the rollers throughout the width of the sheet.

As heretofore explained, the guides are made in sections. The upper guides of each section are secured together as are the lower guides, so that the upper guides may be lifted or swung out of the way to give free access to the work in case there is a damaged sheet in the machine. Furthermore, the feed roll units should also be separable in the same way as the guides. The first section, consisting of the upper and lower guides 14 and 15, may be fixed, as there will almost never be any occasion for opening the guides of this section. The remaining sections are preferably carried by the feed roll frames, so that the lower halves will remain stationary and the upper halves be movable with the upper halves of the feed roll frames.

Except as to proportions the feed roll units, as heretofore stated, are all alike and a description of one will suffice for all of them. Referring to Figs. 8 to 16 it will be seen that each pair of feed roll shafts is supported within a hollow casing open at the sides facing the ends of the machine. In other words, each casing consists of a lower half 25 and an upper half 26 generally channel-shaped in cross-section. The lower feed roll is mounted in bearings in the lower half of the casing and the upper feed roll is mounted in suitable bearings in the upper half of the casing. The upper bearings for the feed rolls are in partition walls 27 and 28, respectively, at some distance from the upper end of the casing, so as to provide in the upper end of the casing a gear chamber. On the ends of the feed rolls projecting into this chamber are gear wheels 29 meshing with each other. One of the rolls is preferably extended beyond its gear wheel and is there provided with a bevel gear 30 meshing with a complementary gear 31 on a drive shaft 32 extending throughout the length of the machine. This drive shaft is made in sections, one for each feed roll unit, the sections being connected by intermediate sections 33 through universal joints 34.

This sectional drive shaft is driven through bevel gearing 35 from the shaft 36 of the roll 5 at the receiving end of the machine. The two halves of each feed roll unit casing are hinged together at their upper ends and are fastened together at their lower ends by a quick detachable connection that will permit each upper casing member to be swung up out of the way. The sheets to be expanded vary more or less in thickness and therefore, in order that they may be properly pulled through the machine by the feed rollers it is necessary that the latter be so arranged that they will yield to compensate for different thicknesses of metal and at the same time maintain a uniform grip on the work. I have therfore so constructed the hinge and the quick detachable connection that the upper member of each casing may yield to suit the conditions at any particular moment. As best shown in Figs. 15 and 16, the hinge pin 37 consists of a central portion and two end portions 38; the end portions being axially aligned and concentrically disposed with respect to the central portion or, the hinge pin may be said to have a long eccentric throughout that part that lies within the upper casing member. An arm 39 extends radially from the middle portion of the hinge pin, and through this arm passes a rod 40 hinged at one end to a post 41 projecting from the lower casing section adjacent to the hinge. On the free end of the rod 40 is a nut 42, and between this nut and the arm 39 is a compression spring 43. The hinge pintles in all of the units are so disposed that a plane containing the two long axes of the end parts and of the eccentric central part is horizontal, as indicated by the lines Y—Y. Therefore, when there is no work in the machine, the weight of the upper half of each feed roll unit and the spring pressure on the hinge pintle that tends to turn the same will cause the upper feed rolls to drop into engagement with the lower feed rolls, unless stops are provided to afford a minimum gap. Then, when a sheet enters between the rolls of any unit and a thickened part is reached, the hinge connection permits the upper roll to move up in a vertical direction to accommodate the increased thickness. The fastening between the lower ends of the two halves of the casing must, of course, be such as to permit the automatic adjusting movements of the upper half of the casing. This may conveniently be accomplished by employing for the quick detachable connection a rod 45 hinged at one end to the lower casing member and swinging laterally into a notch 46 in the upper casing member. On the free end of the rod, above the upper casing member, is a large nut or hand wheel 47 under which, around the rod, is a compression spring 48. By unscrewing the nut or hand wheel, the pressure on the spring 48 is relieved and the rod may be swung out of engagement with the upper half of the casing. When the parts are in locking positions, the lower halves of the casing are yieldingly held together so that, when the upper half is compelled to move vertically to adjust itself, it swings about the hinge axis of the rod 45 at the lower end, at the same time.

The casings are supported from the base of the machine by means of vertical posts in the form of eye bolts of which there are preferably four for each feed roll unit. Referring to Figs. 8 and 9, it will be seen that there are two eye bolts 50 between the upper end of the lower half of the casing and the base, and two shorter eye bolts 51 between the lower end of the lower half of the casing and the base. These eye bolts are fastened to the casing by means of transverse bolts 52 extending through ears 53 on the casing or on members attached to the casing and through the eyes of the eye bolts. The lower ends of the eye bolts pass through the flanges on the base and are secured thereto by means of nuts 54 and 55 arranged respectively above and below the flanges. By adjusting the nuts 54 and 55 of the eye bolts, the angular positions of the feed roll units may be varied. It is also desirable that provision be made for adjusting the feed roll units transversely of the machine to facilitate aligning the units in a lengthwise direction in setting up the machine. Therefore, instead of fastening the supporting eye bolts directly to the casings, I prefer to make the attachments thereof to plates 56 and 57 secured to the undersides of the casings in such a manner that the casings may be shifted bodily thereon in the direction of their lengths. The details of this feature of construction are best shown in Figs. 12 and 14. On the underside of each casing is a guideway 58 extending throughout the length of the casing, and each of the plates 56 and 57 has in the center a thickened part or projection 59 that fits into this guideway, interlocking the plates and the casing so that the long axes of the feed rolls will always remain in the same planes when the casing is shifted on these supporting plates. The plates are held to the casing by means of bolts 60 passing through elongated holes 61 in the plates and into the casing. To facilitate the making of lengthwise adjustments of the casings, I secure on the underside of each a bar 62 parallel with the upper edge of the lower supporting plate 57, and provide the plate 57 with a stud 63 that extends up freely through an opening in the bar. Nuts 64 and 65 are placed on the stud above and below the bar. By adjusting these nuts the casing can be moved a limited distance lengthwise in either direction. The plates 56 and 57 may be connected together by a tie member 66 to

prevent the plates from spreading apart while adjustments are being made.

As heretofore stated, the guide sections are preferably supported from the feed roll units. To this end each half of each casing is provided with a row of outwardly projecting lugs 70 extending along the inner edges of the casing sections; there being as many lugs in each row as there are spaces between the collars on one of the feed rolls. Those guide bar elements that extend continuously past the feed rolls of one unit, namely the bars 14*a* and 15*a*, are supported from these lugs; the bars 14*a* from the lugs on the upper half of the casing and the bars 15*a* from the lugs on the lower half of the casing. This is conveniently accomplished by providing each bar with two studs 71 projecting upwardly from the upper edge if it is an upper bar or downwardly from the lower edge if it is a lower bar; these studs being so spaced apart on each bar that they will pass through suitable openings in the corresponding lugs of the two rows on the adjacent half of the casing. Nuts 72 and 73 are placed on these studs above and below the lugs through which they pass. By adjusting these nuts the cooperating bars of each pair may be adjusted from and toward each other. The lugs are always set on the casings, regardless of the angles at which the latter are set, so that the holes for the studs are vertical, so that transverse lines in the working faces of the guide bars will always be horizontal. Those guide bar elements that are interrupted at the feed rolls, namely the elements 14*b* and 15*b*, are secured against the sides of the corresponding bars 14*a* and 15*a* by means of rivets or pins 75 as best shown in Fig. 9.

It will thus be seen that I have produced a simple and novel machine for expanding slitted sheets in such a manner that only such stresses will be imposed on the metal of the sheet as is needed to open up the strands, without imposing any stresses that would tend to stretch or otherwise distort the strands or the ribs.

I have spoken of the guide bars being bent or curved, that is, extending gradually out of the plane in which their front ends lie, without being twisted about their longitudinal center lines. For all practical purposes, since the bars are made in short sections, the individual sections may be straight, so that each guide bar, considered as a whole and as extending from one end of the machine to the other, takes the form of a curve.

While I have illustrated and described with particularity only a single preferred form of machine, I do not desire to be limited to the exact details thus illustrated and described; but intend to cover all forms, arrangements and series of operations coming within the definitions of my invention constituting the appended claims.

I claim:—

1. In a machine of the character described, a series of pairs of feed rolls spaced apart from each other and having their axes of rotation in parallel planes, the axes of the pairs of rolls being displaced angularly of each other, the angular displacement between consecutive pairs of rolls decreasing progressively from the receiving end of the machine, guides for the work between the pairs of rolls, and the rolls throughout the series having stock-engaging portions shaped to contact with the stock in parallel horizontal planes.

2. In a machine of the character described, a plurality of pairs of guides, each pair consisting of an upper guide and a lower guide, the receiving ends of said pairs of guides being in one plane and the pairs of guides being gradually extended out of said plane without being twisted, feed rolls extending across the guides at intervals, alternate guides being interrupted at said feed rolls and the remainder passing through the rolls.

3. In a machine of the character described, a plurality of pairs of guides, each pair consisting of an upper guide and a lower guide, the receiving ends of said pairs of guides being in one plane and the pairs of guides being gradually extended out of said plane without being twisted, feed rolls extending across the guides at intervals, alternate pairs of guides being interrupted at the feed rolls, and said feed rolls having feeding zones located in the gaps of said pairs of guides and clearance spaces to permit the passage of the remaining guides.

4. In a machine of the character described, a plurality of pairs of guides, each pair comprising two guides one above the other, the pair of guides being in the same plane at the receiving end and being gradually extended out of said plane at different rates without being twisted, pairs of feed rolls extending across said guides at intervals, and means for supporting the guides and the rolls to permit the upper guides and the upper rolls to be lifted to expose the work.

5. In a machine of the character described, a plurality of pair of guides, each pair comprising two guides one above the other, the pairs of guides being in the same plane at the receiving end and being gradually extended out of said plane at different rates without being twisted, pairs of feed rolls extending across said guides at intervals, and means for supporting the guides and the rolls to permit the inclination of the guides and the rolls to be varied.

6. In a machine of the character described, a unit comprising an elongated casing composed of two members engaged at their ends and spaced apart for the major portions of their lengths, parallel feed rollers mounted one on each of said members in the space be-

tween them, parallel cooperating guide bars projecting from said members in a plane passing between said rolls, a hinge between said members at one end, and a quickly-detachable connection between the other ends of said members.

7. In a machine of the character described, a series of expanding units arranged end to end, each unit comprising a support, a pair of feed rolls on the support, and pairs of cooperating guide bars mounted on said support and extending from the rolls midway between the latter, said units being displaced from each other in the same direction at progressively decreasing angles, corresponding guide bars throughout the series being positioned in the same vertical plane and all of the bars except those of one pair throughout the series being gradually extended out of a plane at right angles to the aforesaid plane without being twisted.

8. In a machine of the character described, a group of pairs of guide bars lying in parallel planes curved gradually in the same direction in their planes without being twisted and at a progressively increasing rate across the group, and means for gripping a sheet to be expanded along alternate pairs of guide bars and drawing the same through the machine.

9. In a machine of the character described, two equal series of pairs of long guide bars whose longitudinal center lines lie in parallel planes, the central guide bar being straight and the bars of one series being gradually curved in one direction in said planes at rates that increase with the distance of the bar from the straight bar, and the bars of the other series being gradually curved in the opposite direction at rates that increase with the distance from said straight bar.

10. A group of pairs of long guides arranged in parallel planes, the central pair being straight, the guides on one side of the central pair being curved gradually in one direction in their planes and the guides on the other side of the central pair being curved gradually in the opposite directions in their planes, the curvature of each curved pair of guides being at a gradually decreasing rate, and the rate of curvature of the guides increasing with their distance from said central pair.

11. In a machine of the character described, a group of spaced pairs of cooperating guides, the guides of each pair being adapted to receive between them a rib section in a sheet composed of alternate slitted and rib sections, the receiving ends of the guides being in a single plane and the guides being gradually extended out of said plane without being twisted, the degree of the divergence increasing from one end of the group to the other, and feed rolls distributed along the guides to engage the rib sections of the work and draw the work along the guides.

12. In a machine of the character described, a unit comprising an elongated casing composed of two members engaged at their ends and spaced apart for the major portions of their lengths, parallel feed rollers mounted one on each of said members in the space between them and extending lengthwise thereof, a series of pairs of guide bars lying approximately in a plane passing between said feed rollers and at right angles to a plane containing the long axes of said rollers, one bar of each pair being fixed on one of said members and the other bar on the other member, and means for fastening said members together so as to permit them to be separated at will.

13. In a machine of the character described, a group of parallel pairs of guide bars, each pair being curved gradually in the same direction without being twisted and at a progressively increasing rate across the group, transverse lines on the working faces of said guides all being parallel with each other, and means for gripping a sheet to be expanded at intervals along alternate pairs of guide bars and drawing the same through the machine.

14. In a machine of the character described, a series of feed roll units, each unit comprising two long parallel shafts, means supporting said shafts, a plurality of collars distributed along each shaft, the peripheries of said collars being frusto-conical, the collars on the two shafts of each unit being oppositely disposed so that between the periphery of each collar and the periphery of the opposite collar is a narrow space to receive a ribbed section of a sheet that is being expanded, the shafts of the several units lying in planes parallel to each other, the shafts in the several units being arranged at progressively increasing angles to a plane at right angles to the aforesaid planes from one end of the series to the other, and pairs of guide devices extending from one unit to the other.

15. In a machine of the character described, a series of feed roll units, each unit comprising two long parallel shafts, means supporting said shafts, a plurality of collars distributed along each shaft, the peripheries of said collars being frusto-conical, the collars on the two shafts of each unit being oppositely disposed so that between the periphery of each collar and the periphery of the opposite collar is a narow space to receive a ribbed section of a sheet that is being expanded, the shafts of the several units lying in planes parallel to each other, the shafts in the several units being arranged at progressively increasing angles to a plane at right angles to the aforesaid planes from one end of the series to the other, pairs of guide

devices extending from one unit to the other, some of said guide devices passing continuously from one side of a unit to the other side in the space between the pairs of opposed collars.

In testimony whereof I sign this specification.

FRED C. AREY.