Feb. 26, 1929. 1,703,456

F. M. POTTER

METHOD OF AND APPARATUS FOR FOLDING SHEET MATERIAL

Original Filed May 19, 1923 3 Sheets-Sheet 1

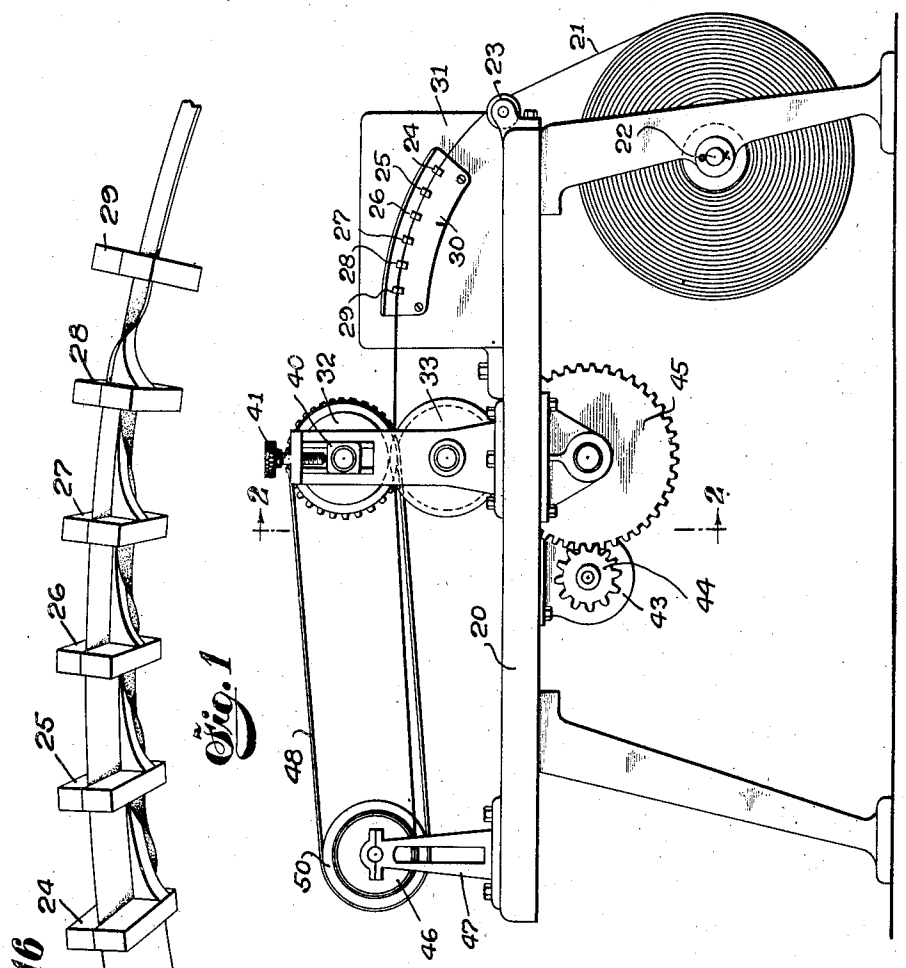


Fig. 1



Fig. 1a

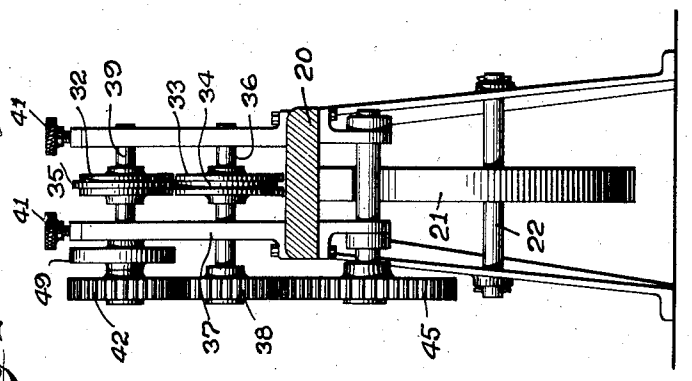


Fig. 2

Inventor
Frank M. Potter
By his Attorneys
Emery, Booth, Janney & Varney

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F. M. POTTER

METHOD OF AND APPARATUS FOR FOLDING SHEET MATERIAL

Original Filed May 19, 1923 3 Sheets-Sheet 2

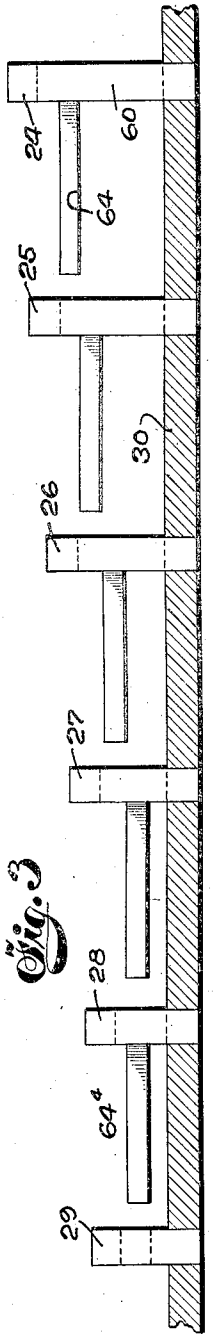



Fig. 3

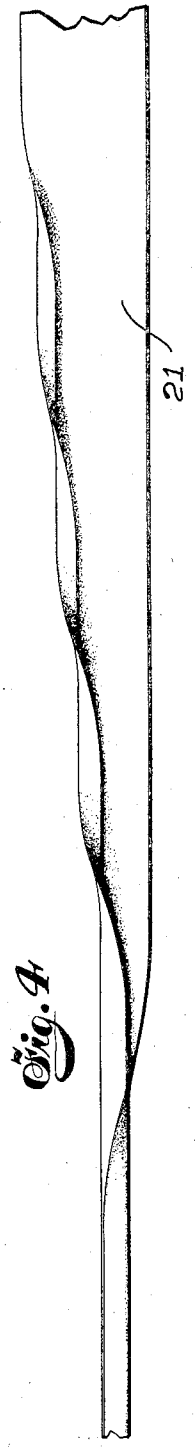



Fig. 4

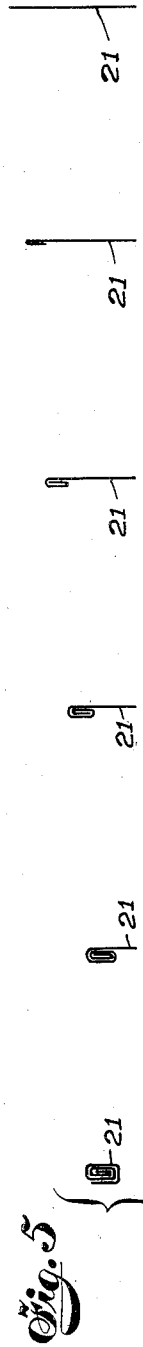



Fig. 5

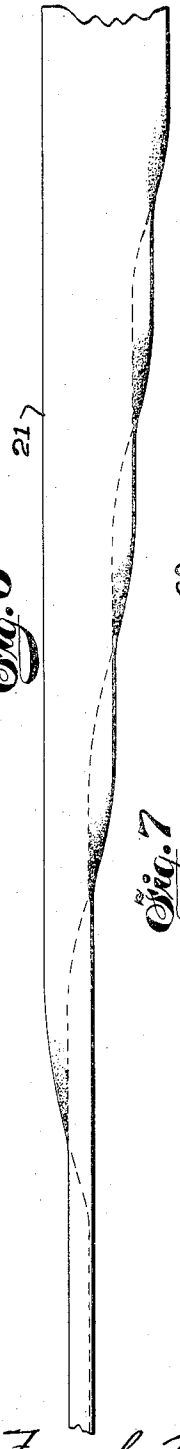



Fig. 6

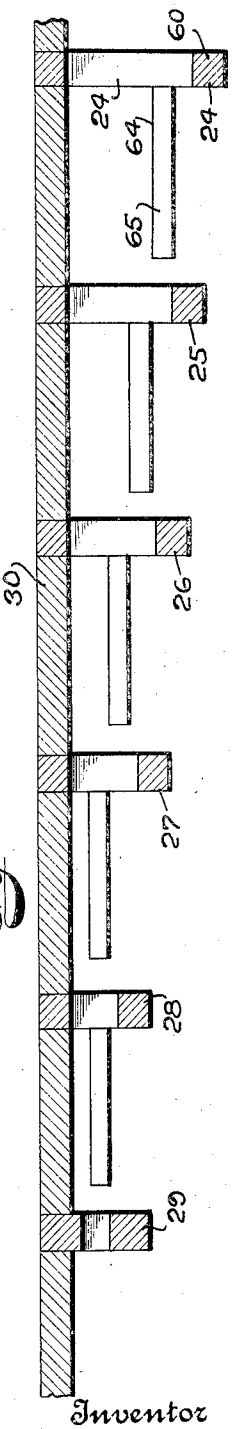



Fig. 7

Inventor
Frank M. Potter
By his Attorneys
Emery, Booth, Janney & Varney

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F. M. POTTER

METHOD OF AND APPARATUS FOR FOLDING SHEET MATERIAL

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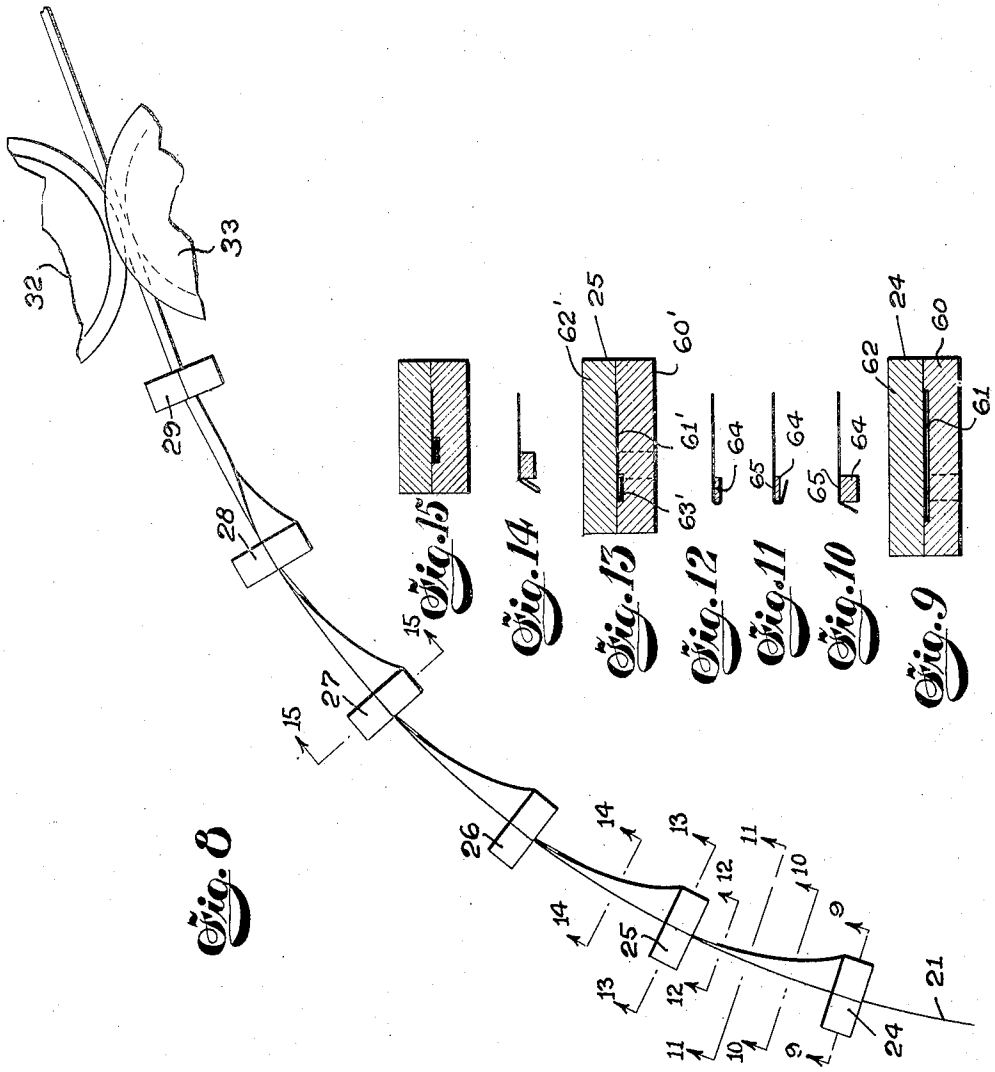



Fig. 8



Fig. 15



Fig. 14




Fig. 13




Fig. 12




Fig. 11




Fig. 10




Fig. 9

Inventor

Frank M Potter

By his Attorneys

Emery, Booth, Janney & Varney

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# UNITED STATES PATENT OFFICE.

FRANK M. POTTER, OF ROME, NEW YORK, ASSIGNOR TO GENERAL CABLE CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

## METHOD OF AND APPARATUS FOR FOLDING SHEET MATERIAL.

Application filed May 19, 1923. Serial No. 640,288. Renewed July 19, 1928.

The present invention relates to improvements in the art of folding flat stock and comprehends improvements in the method of folding, in apparatus for performing the folding operation and in the resulting structure.

Among other objects the invention aims to provide a method and apparatus by which a strip of flat stock may be folded along longitudinal lines in indeterminate lengths and in the particular embodiment of the invention herein illustrated another object of the invention is to produce a laminated structure in indeterminate lengths from a strip of flat stock of single thickness.

The particular embodiment of the invention herein selected for illustration and description comprehends a method and apparatus by which a laminated tape of fibrous material such as paper may be produced from a strip of material of a single thickness, although it will be apparent that at least certain features of the invention are useful in other connections. For the purposes of this description, reference will be made only to the specific embodiment of the invention shown and to the product which that embodiment is particularly designed to produce.

Laminated paper tape such as that shown and described herein may find many different uses in widely diversified industries, in fact it will be useful wherever a relatively flexible and strong tape is desirable. It will be particularly useful as a structural element in the protective and insulating covering of electrical conductors inasmuch as paper possesses insulating properties and when properly treated and applied provides an excellent protective covering for the conductor. Inasmuch as the present embodiment of the invention is primarily intended for use as an element in the covering material of electrical conductors it will be described solely in that connection, although other uses for the tape will at once be apparent.

A preferred embodiment of the invention has been selected for illustration and is shown in the accompanying drawings, wherein

Figure 1 is a side elevation of folding apparatus particularly designed for converting flat stock into a laminated tape,

Figure 2 is a cross-section thereof on the line 2—2 of Figure 1,

Figures 3 to 7 inclusive are semi-diagrammatic views which illustrate the drawing dies and the manner in which the folding of a strip of flat paper stock is accomplished; Figure 3 being a view of the drawing dies from beneath; Figure 4 being a view of the tape from beneath showing the successive folds; Figure 5 consisting of a series of cross-sections of the tape as it progresses from flat stock at the right to the final product at the left; Figure 6 being a view of the tape from above showing the manner in which it is folded; and Figure 7 being a view of the drawing dies from above.

Figure 8 is a diagrammatic elevation of the drawing dies looking from the rear of Figure 1 with the plate upon which the dies are mounted removed.

Figures 9 to 15 inclusive are cross-sections on the lines 9—9, 10—10, etc, of Figure 8, and

Figures 16 is a perspective view of the drawing dies showing the paper passing therethrough and looking from the back of the machine shown in Figure 1.

Referring to the drawings, the operating parts of a suitable apparatus embodying the invention are mounted upon a bed plate 20. A supply of flat stock, herein a strip of paper 21, is carried by a spindle 22 journaled between two supporting legs of the bed 20. This strip of paper 21 is led over a guide roll 23 and through a series of drawing dies 24 to 29 inclusive which are fixed in a plate 30 mounted upon a standard 31 fast to the bed of the machine. These drawing dies, which will later be described in detail, operate to fold the paper upon itself a suitable number of times and the paper so folded is led between rolls 32 and 33 which not only act as feed rolls but also operate to firmly crease the tape and gauge the size thereof. The feed roll 33 is provided with a peripheral groove 34 which cooperates with a peripheral ridge 35 on the

face of the feed roll 32. The feed roll 33 is fast to a shaft 36 which is journaled in fixed bearings in similar standards 37 and carries a gear 38 at its outer end. The feed roll 32 is fast to a shaft 39 which is journaled in similar sliding blocks 40 so that the two shafts 36 and 39 may be moved toward or away from each other. Means are provided for forcing the feed rolls into contact with the tape, herein shown as similar screws 41 adapted to press downwardly upon the sliding blocks 40. The shaft 39 carries a gear 42 at its outer end which meshes with gear 38 on shaft 36 so that the two feed rolls turn at the same speed in opposite directions and the diameters of the peripheral ridge 35 and groove 34 are the same so that the peripheral speed of the parts of the two feed rolls in contact with the tape will be the same.

The feed rolls are driven by any suitable source of power such as the motor 43 which carries a pinion 44 meshing with intermediate gear 45 which also meshes with the gear 38.

Any suitable means for reeling or spooling the folded tape may be provided and are herein illustrated as a reel 46 journaled in standards 47 rising from the bed plate 20 and frictionally driven by a belt 48 which runs over a pulley 49 upon the shaft 39 and the pulley 50 upon the shaft carrying the reel.

The construction of the drawing dies will be clearly understood from an examination of Figures 8 to 15 inclusive, it being unnecessary to describe each die in detail inasmuch as they resemble each other in certain respects. For example, the die 24 consists of two parts which are both mounted in the plate 30. The lower part 60 of this die is cut away at 61 so that in cooperation with the upper part 62 of the die it forms an aperture of a length equal to the width of the tape and of a width which will permit the tape to be easily drawn therethrough. This and the succeeding dies are herein shown as adapted to form a laminated tape which is folded upon itself four times from one edge and once from the other edge, producing a finished product in which there are six laminæ. Inasmuch as each successive folding of the paper requires a slightly greater amount of stock to effect the fold, the second die 25 has its lower part $60^1$ cut away to a less extent to form the aperture $61^1$ of a length less than the aperture 61 by a little less than one-fifth the original width of the flat stock. This second die 25 resembles the first in that it has an upper part $62^1$, but the cut away portion of the lower part $60^1$ is different in that it is cut away for approximately one-fourth of its length to a depth slightly greater than two thicknesses of the original stock forming a wider aperture at $63^1$ and a narrow aperture for the rest of its width which is not much greater than the thickness of the original flat stock.

In order to guide the edge of the flat stock to the position shown in Figure 13, thereby forming the first fold, a guide member or shoe 64 having an arcuate surface 65 is mounted upon and projects forwardly from the lower part 60 of the drawing die 24. The manner in which this shoe or guide acts to position the first fold of the paper tape is clearly illustrated in Figures 10, 11, 12 and 16 and will be apparent without further description. The successive dies 26, 27, 28 and 29 are formed with apertures successively narrower than those of the dies 24 and 25 and the final die 29 has an aperture just long enough to accommodate the finally folded tape and wide enough to permit the six thicknesses of the flat stock to be drawn therethrough.

Corresponding parts of the successive dies are correspondingly numbered with the exponent "1" for the parts of die 25, exponent "2" for the parts of die 26 and so on.

As the flat strip is drawn through the dies it will be observed that the outer or lefthand edge in Figures 9 to 15 is repeatedly folded under. During this folding, assuming that the paper was being drawn in a straight line, the distance from one die to the next along the irregular line of the lefthand edge of the tape would be greater than the distance along the straight line on the righthand edge of the tape or a straight line at any intermediate point. In order therefore to prevent stretching or tearing of the paper along the edge which is being folded, the dies are preferably arranged as shown upon the arc of a circle of suitable radius. This tends to shorten the distance between successive dies along the irregular lefthand edge of the tape inasmuch as the irregular edge then approximates a chord of the arc. By lessening the strain on this edge, the danger of tearing the tape will be minimized.

Figures 3 to 7 inclusive illustrate very clearly the manner in which the tape is folded and the relation of the successive dies to the folds in the tape. These figures are diagrammatic to the extent that they do not show the dies arranged upon the arc of a circle, otherwise they are entirely in accordance with the other figures of the drawings. These figures are arranged so that the tape and dies are located in respect to each other as they are located in the machine, that is to say, the die 24 is apertured to pass the tape in the condition shown along the vertical line between the two representations of that die in Figures 3 and 7. The die 25 accommodates the tape with one fold as shown directly therebelow. The same is true of the other dies shown in Figures 3 and 7. It

will be seen by reference to these figures and Figure 16 that the outer edge of the flat strip first bends upwardly in Figure 4, (downwardly in Figure 6) and is then drawn over or under as the case may be and pressed flat against the undeformed surface of the tape and creased in the die 25. Similarly the doubled edge is again folded back upon the body of the tape and pressed into contact therewith by the die 26. All these folds take place in the same direction until die 28 is reached. The shoe or guide $64^4$ is so arranged with respect to the aperture in the die 28 that the inner or unfolded edge of the tape will now be bent down over the edge of the said guide and the tape, folded into a structure of six thicknesses, will issue from the die 29. Thereafter the tape passes between the rolls 32 and 33 and is firmly pressed together.

Tape manufactured in accordance with the present invention has been found to be a very excellent material for insulating and protecting electrical wires or cables. This is in part due to the fact that the tape is of uniform cross-section throughout, each layer being unattached except at its edge to any other layer and thereby permitting a slight relative movement or accommodation of the laminated tape to the wire or cable which is being covered. This avoids tears or wrinkles and permits the tape to be wound helically about the conductor with extreme accuracy so that the edges of successive convolutions abut closely. Moreover this laminated construction is of advantage to increase the flexibility of the finished product inasmuch as the several laminæ permit the tape to bend upon transverse lines and thus the tape will accommodate itself to any curvature which the electrical cable may take during installation and use and without unduly opening up the seams between adjacent convolutions. Furthermore, this form of tape results in an economy in the operation of covering electrical conductors in that it may be wound thereon very speedily due to its tensile strength and to the fact that a plurality of layers of paper are thus being applied to the conductor simultaneously.

It will be understood that the invention may be variously modified and embodied within the scope of the subjoined claims.

I claim as my invention:

1. A method of folding strips of indeterminate length, which consists in successively folding a single edge of the strip toward the opposite edge, said successive folding operations being performed about an arcuate path, and finally subjecting said folded strip to a compressive force adapted to firmly crease the same.

2. A method of folding strips of indeterminate length, which consists in drawing a strip through a succession of dies arranged in an arcuate path, and adapted to impart successive folds to one edge of the strip, and then passing said strip through another die also arranged on said arcuate path and adapted to impart a fold to said other edge.

3. A method of folding strips of indeterminate length, which consists in drawing a strip through a succession of dies arranged in an arcuate path and adapted to impart successive folds to one edge of the strip, then passing said strip through another die also arranged on said arcuate path and adapted to impart a fold to said other edge, and finally subjecting said folded strip to a compressive force adapted to firmly crease the same.

4. In a machine for folding strips of material, in combination, means for feeding a strip through said machine; a succession of dies through which said strip may be fed; and means for holding said dies in an arcuate path.

5. In a machine for folding strips of material, in combination, means for feeding a strip through said machine; a succession of dies through which said strip may be fed; means between said dies for imparting a fold to an edge of said strip; and means for holding said dies and folding means in an arcuate path.

6. In a machine for folding strips of material, a plurality of dies arranged upon the arc of a circle and having relatively narrow apertures of progressively lessening width.

7. In a machine for folding strips of material, a plurality of dies arranged upon the arc of a circle and having relatively narrow apertures of progressively lessening width; and means between said dies to determine the extent of successive folds.

8. In a machine for folding strips of material, in combination, means for feeding a strip through said machine; a succession of dies through which said strip may be fed; means for holding said dies in an arcuate path; and means whereby said feed means may also compress the folded strip.

9. In a machine for folding continuous strips, in combination, means for feeding a strip through said machine, a series of dies arranged in an arcuate path and shaped to impart successive folds to one edge of the strip.

10. In a machine for folding continuous strips, in combination, means for feeding a strip through said machine, a series of dies through which said strip is drawn successively, said dies being arranged to impart successive folds to one edge only of the strips said dies being arranged in an arcuate path and means for finally subjecting said folds to a compressive force adaped to firmly crease the same.

11. In a machine for folding continuous

strips, in combination, a series of dies arranged in an arcuate path adapted to impart successive folds to one edge only of the strip, another die arranged to impart a fold to the other edge of the strip, and means for drawing the strip through the several dies.

12. In a machine for folding strips of material, a plurality of dies arranged upon the arc of a circle and having relatively narrow apertures of progressively lessening width and means between said dies over which an edge of the strip is folded as it passes from die to die.

In testimony whereof, I have signed my name to this specification this 18th day of May, 1923.

FRANK. M. POTTER.