April 23, 1935. F. J. MacDONALD 1,998,815

METHOD AND APPARATUS FOR WEAVING ARTICLES OF CURVILINEAR FORM

Filed Jan. 27, 1934 4 Sheets-Sheet 1

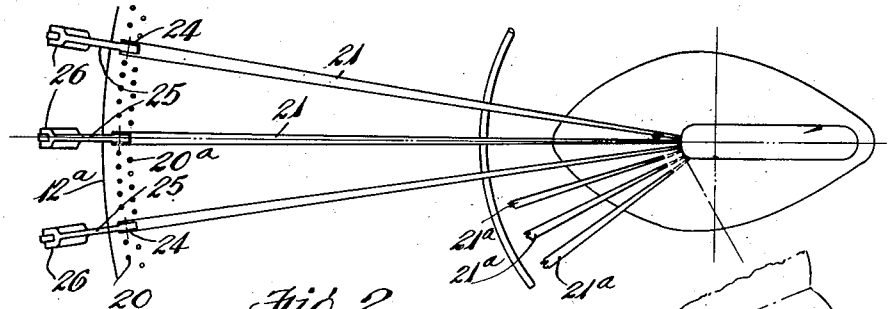


Fig. 2.

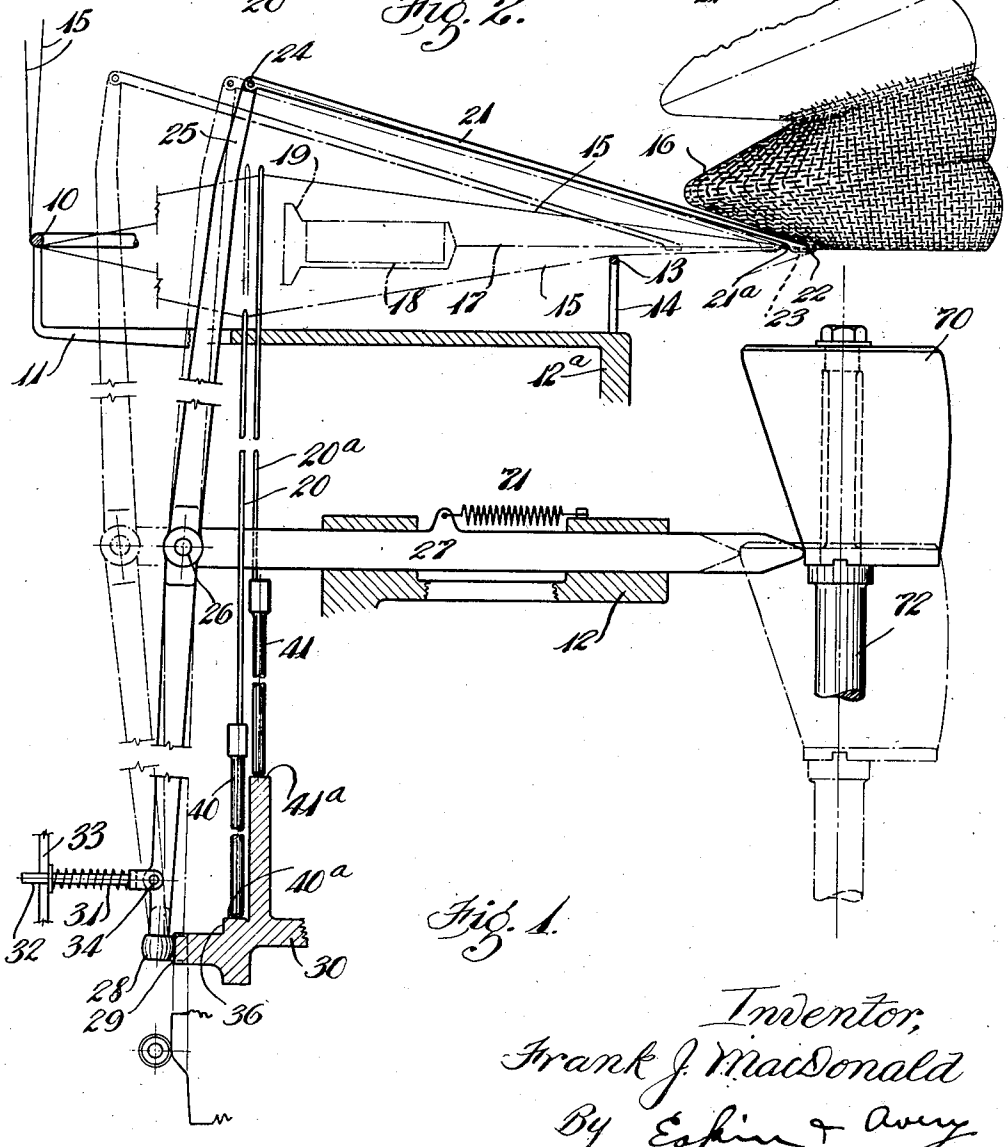


Fig. 1.

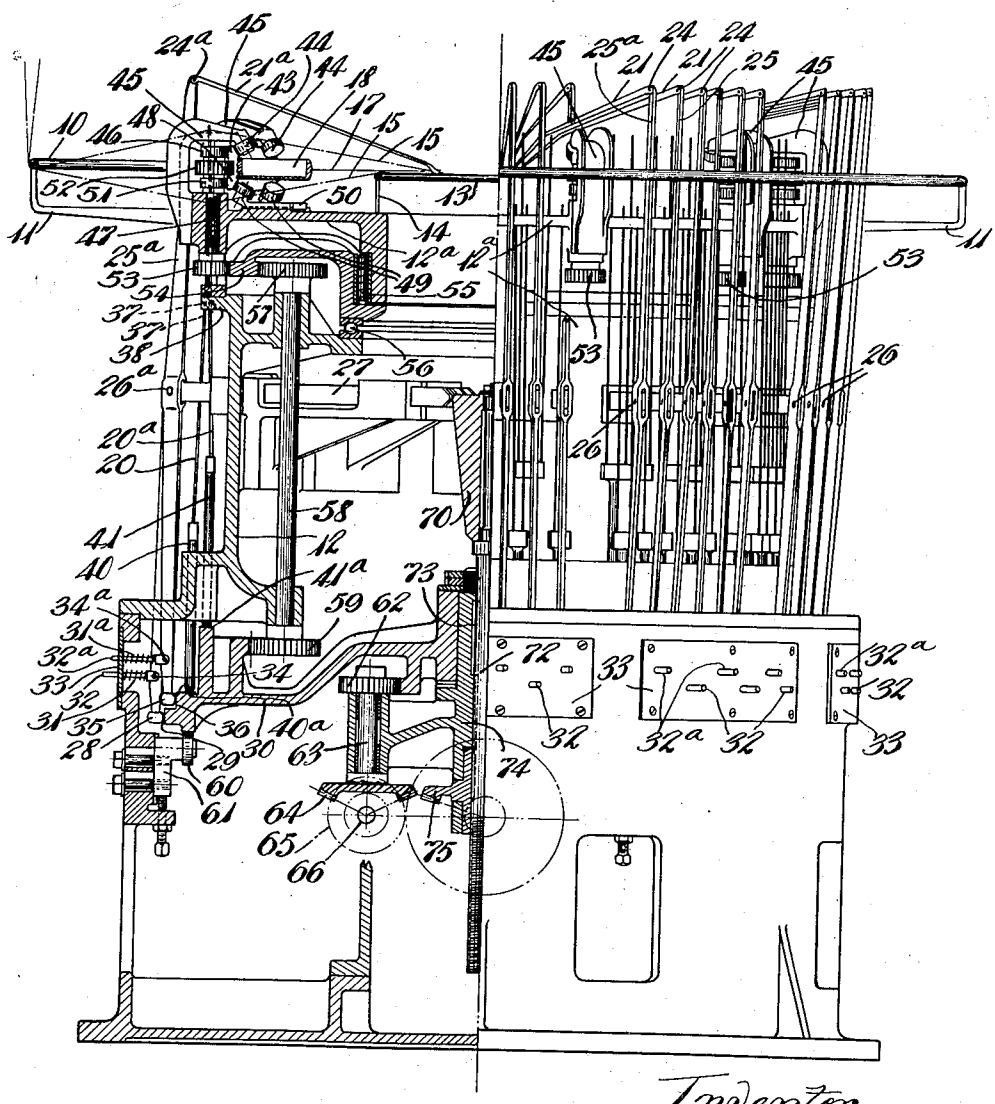
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Filed Jan. 27, 1934 4 Sheets-Sheet 2

Fig. 3.



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Filed Jan. 27, 1934 4 Sheets-Sheet 3

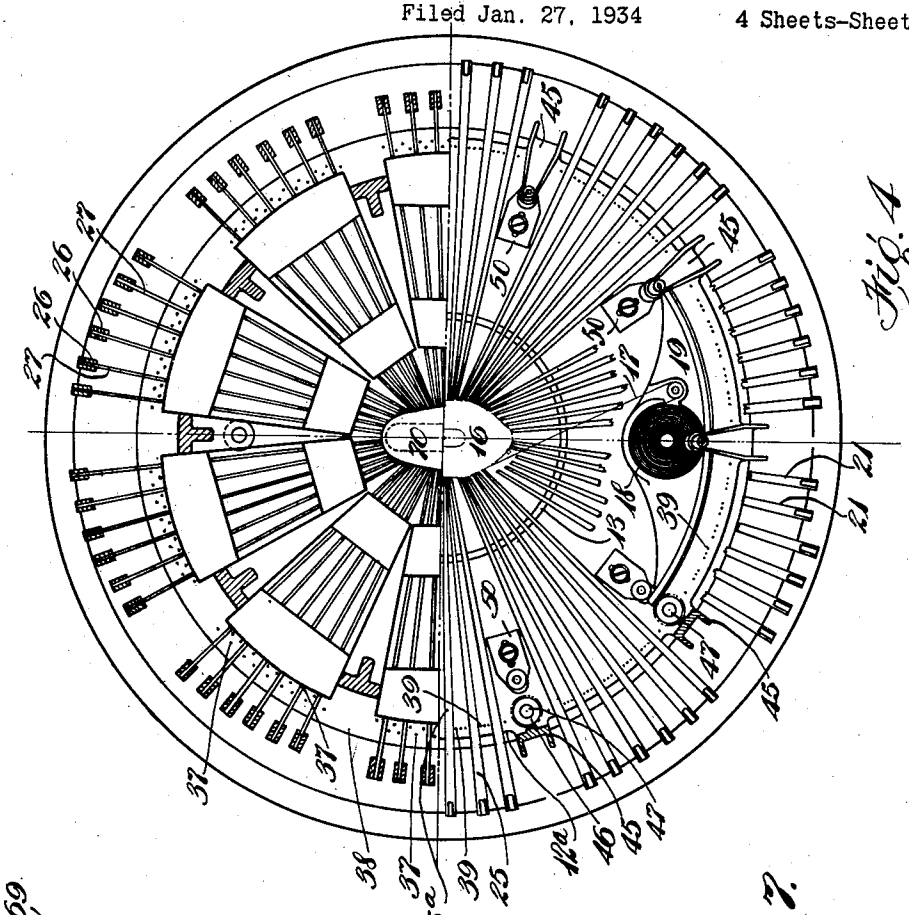


Fig. 4

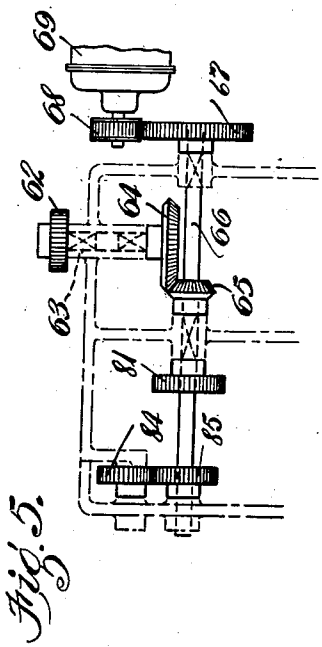


Fig. 5.

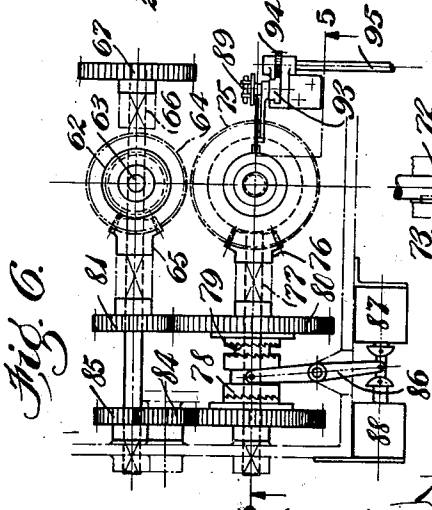


Fig. 6.

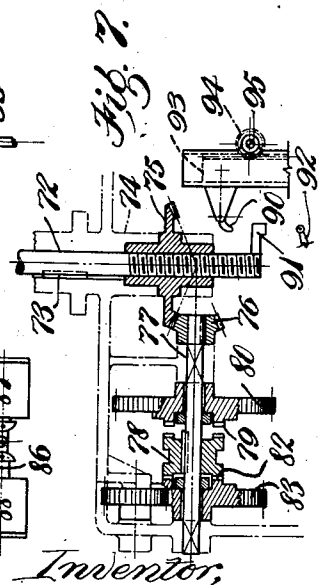


Fig. 7.

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Filed Jan. 27, 1934 4 Sheets-Sheet 4

Fig. 8.

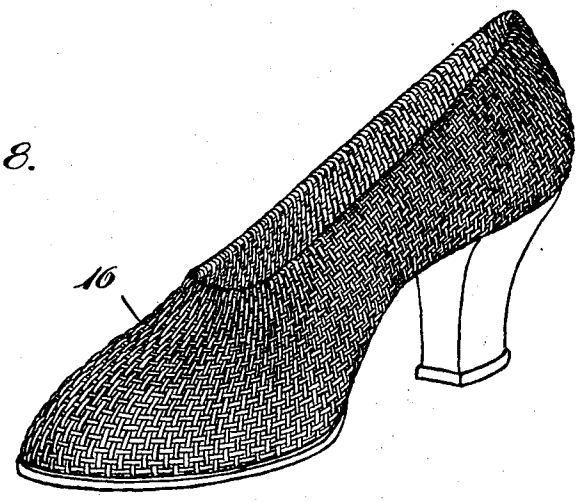
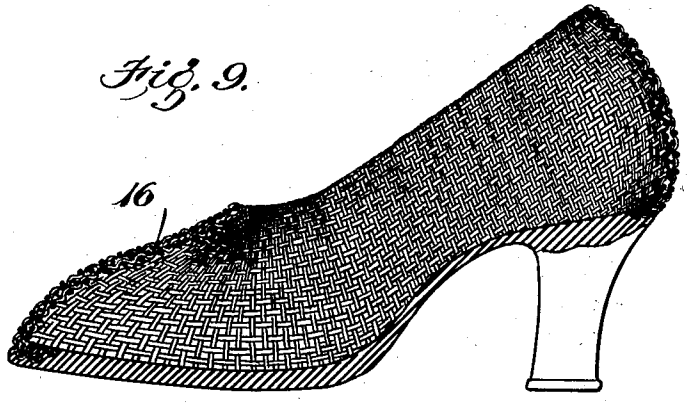


Fig. 9.



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UNITED STATES PATENT OFFICE

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METHOD AND APPARATUS FOR WEAVING ARTICLES OF CURVILINEAR FORM

Frank J. MacDonald, Brookline, Mass., assignor to Hood Rubber Company, Inc., Watertown, Mass., a corporation of Delaware

Application January 27, 1934, Serial No. 708,548

22 Claims. (Cl. 139—13)

This invention relates to procedure and apparatus for weaving tubular structures of fibrous or other threads or strands, the invention being of especial value in weaving shoe uppers or combined shoe-uppers and linings to shape or approximately to shape.

Its chief objects are to avoid waste of material such as occurs in cutting shoe uppers or linings from flat sheet material, to provide for a highly automatic machine for weaving a succession of the articles to shape, to provide for the weaving to shape of articles of non-symmetrical form, to provide for so weaving such articles without changing the number of warp or weft threads in the course of the operation, to provide a machine of wide and ready adaptability for articles of different sizes and shapes, and to provide for simplicity and economy of construction and operation.

Of the accompanying drawings:

Fig. 1 is a diagrammatic side elevation of parts of a machine embodying and adapted to carry out my invention in its preferred form.

Fig. 2 is a diagrammatic plan view of parts of the same.

Fig. 3 is a side elevation of the machine and with parts shown in section and with parts omitted for clearness of illustration.

Fig. 4 is a plan view of the same with parts sectioned and with parts removed.

Fig. 5 is an elevation of the top portion of the mechanism of Fig. 6 together with the motor and motor-shaft pinion.

Fig. 6 is a plan view of parts of the said drive mechanism.

Fig. 7 is a partially sectional view along line 5—5 of Fig. 6.

Fig. 8 is a perspective view of a shoe having as a part thereof a combined upper and lining made by the practice of my invention.

Fig. 9 is a longitudinal section of the same.

Referring to the drawings, the machine here illustrated comprises a horizontal outer guide ring 10 supported by brackets 11, 11 from the machine frame 12 and a horizontal inner guide ring 13 supported by brackets 14, 14 from the machine frame, the two guide rings being adapted to guide a circumferential series of warp threads 15, 15 which are drawn from a suitable source of supply such as a series of overhead spools (not shown), these warp threads 15 passing under the outer guide ring 10, thence radially of the machine over the inner guide ring 13 and to their respective points of incorporation in the work, which is here shown as a tubular structure 16 adapted to be severed into shoe uppers or linings for upper-and-lining combinations. Initially the warp threads are held in position for the starting of the tubular structure by simply being tied together at the center of the weaving plane.

A shuttle thread or weft, of which there may be one or more, preferably two, from respective shuttles, is shown at 17 coming from a spool 18 in a shuttle 19 and for spreading the warps to permit the shuttle or shuttles to pass between them each warp runs through an eye formed in the upper end of a guide needle such as the alternating needles 20 and 20^a having mechanism for raising and lowering them in suitable timed relation, the needles 20 being down when the alternate needles 20^a are up.

For "beating up" or suitably placing the weft thread radially of the work after each passage of the shuttle and holding the weft in place while the adjacent warp threads are reversely spread and thus recrossed back of the weft, the machine comprises a circumferential set of inclined, radially disposed pushers 21, 21, permissibly much fewer in number than the warp threads, and each pusher is formed with an inner end face such as the face 22 (Fig. 1) for engaging the weft and with a guide slot such as the slot 23 (Fig. 1) in the lower face of its inner end portion for reception of one or more of the adjacent warps, so that the inner end of the pusher is adapted to slide upon and be guided by the warp or warps upon which its inner end rests and the head of the pusher being formed with a bevel cam shoulder 21^a (Fig. 1) to permit the weft thread to slide under it and between it and the warp in moving inward to its position in the work, when the pusher is resting upon a warp in down position when the shuttle passes for subsequent engagement by the end face 22 of the pusher. The outer end of each pusher is hinged at 24 to the upper end of a two armed lever such as the levers 25 or 25^a, each of which is fulcrumed at 26 on a radially disposed slide bar 27 mounted in the machine frame 12. Each lever 25 is provided at its lower end with a cam roller 28 coacting with a rotating cam face 29 formed on a cam member 30 which is concentrically journaled upon the machine frame, the roller 28 being held in engagement with the cam face 29 by a compression spring 31 surrounding a spring post 32 and interposed between the lower arm of the lever 25 and one of a series of guide plates 33, 33 secured to the machine framing, the spring post being pivoted to the lever at 34 and slidably mounted in a guide aperture formed in the plate 33.

Alternate levers of the set, designated 25^a (Fig. 3), have lower arms of slightly different shape and shorter length as compared with the lower arms of the intervening levers 25 and each is provided at its lower end with a cam roller 35 coacting with a cam face 36 formed on the cam member 30, with which it is held in association by a compression spring 31^a mounted on a spring post 32^a which is hinged to the lever arm at 34^a and is slidably mounted in a guide aperture formed in

the adjacent plate 33, this arrangement avoiding such crowding of the cam rollers and spring post assemblies as would result if all of the cam rollers coacted with the same cam face, while providing successive actuation of the pusher levers progressively about the machine by the two cam faces 29 and 36 so that all of the pushers act similarly and in succession as a single set, although, when two shuttles are employed the cams 29 and 36 are so formed as to have at all times a plurality of adjacent pushers in retracted position just in advance of the weft laying position of each shuttle, one of the two groups of retracted pushers being shown clearly in Fig. 4.

The pusher assemblies are mounted in groups, circumferentially of the machine for convenience in assembling and disassembling and to provide space between groups for shuttle-guiding and driving devices, although at their inner ends, as shown clearly in Fig. 4, the pushers are substantially uniform in their circumferential spacing.

The alternate warp-guiding needles 20 and the intervening warp-guiding needles 20^a are guided in staggered guide apertures 37, 37 formed in an annular flange 38 of the machine frame (Figs. 3 and 4) and in circumferentially aligned guide apertures 39, 39 formed in the margin of a table portion 12^a of the machine frame. The alternate needles 20 are secured at their lower ends in the tops of respective vertical cam-follower holders such as the holder 40 which are mounted for vertical sliding movement in respective guide apertures in the machine frame and rest at their lower ends upon an annular cam face 40^a formed on the cam member 30. Likewise the intervening needles 20^a are secured at their lower ends in the tops of respective vertical cam-follower holders such as the holder 41 which are mounted for vertical sliding movement in respective guide apertures in the machine frame and rest at their lower ends upon an annular cam face 41^a formed on the cam member 30.

For guiding and driving the shuttles 19 each shuttle is formed with an upper guide flange 43 formed with a beveled inner face and adapted to be guided between oblique guide rollers 44, 44, mounted on overhanging brackets 45, 45 which rise from the machine frame, and vertical guide rollers 46, 46 mounted upon vertical drive shafts 47, 47, and each shuttle also is formed with a lower guide flange 48 having a beveled inner face and adapted to be guided between oblique guide rollers 49, 49, mounted upon adjustable brackets 50, 50 secured upon the machine frame, and vertical guide rollers such as the roller 51 (Fig. 3) mounted upon the vertical shafts 47, and the middle portion of the outer side of each shuttle is formed as a gear segment adapted to mesh with successive pinions such as the pinion 52 (Fig. 3) secured upon the vertical shafts 47, each shuttle being of sufficient length circumferentially of the machine to mesh with each successive pinion just before passing out of mesh with the adjacent one, and the vertical shafts 47 having drive connection, through pinions 53, 53 secured on their lower ends and meshed with the outer teeth of a large gear 54 which is journaled in the frame on a roller radial bearing 55 and a ball thrust bearing 56 (Fig. 3) and is formed with a set of internal gear teeth which are meshed with a pinion 57 secured upon the upper end of a vertical shaft 58 which has secured upon its lower end a pinion 59 meshed with a set of internal gear teeth formed upon the cam member 30. The cam member 30 is peripherally supported by a series of rollers such as the roller 60 journaled upon respective brackets such as the bracket 61 adjustably mounted upon the frame. The drive from the cam member 30 back to the motor comprises a set of gear teeth formed on its hub and meshed with a pinion 62 on a vertical shaft 63 having on its lower end a bevel gear 64 meshed with a bevel gear 65 on a horizontal shaft 66 having a gear 67 meshed with the shaft pinion 68 of a motor 69 (Fig. 5).

For changing the positions of the fulcrum points 26 of the pusher levers 25, 25^a as the weaving progresses and thus to control the positions to which the inner ends of the pushers will be advanced in their successive weft-positioning movements the inner ends of the slide bars 27 bear against a vertically reciprocating master form member or cam 70 positioned at the middle of the machine, under the force of respective pull springs such as the spring 71 (Fig. 1) connecting the slide bars with the machine frame, the master form being shaped non-symmetrically in the case of a machine for weaving shoe uppers, as is clearly shown in Fig. 1, so that the successive inner positions of the pushers about the front or toe portion of the upper will be farther apart than the successive positions of those about the rear or heel portion of the upper, to provide for weaving the greater distance down the front than down the back of the upper with only the same number of passages of the weft thread or threads, reliance being had upon the action of the pushers rather than upon different tensions in the warps fore and aft for controlling the spacing of the wefts at the front and rear of the upper, so that relative tension of warp and weft may be more freely available for control of relative "crimp" in the two types of threads instead of being dictated by considerations of weft spacing.

For supporting the master form 70 and moving it up and down in suitably timed relation to the functioning of the bobbins and the guide needles and the pushers, the master form is mounted upon the upper end of a slide-bar 72 which is splined by means of a key 73 in a bearing member 74 constituting a part of the machine frame and the lower end portion of the bar 73 is formed with a screw thread which is engaged with a screw thread formed in the hub of a bevel gear 75 which is swiveled in the lower end of the bearing member 74 and meshed with a bevel gear 76 secured upon a horizontal shaft 77.

For turning the shaft 77 in one direction and then the other the shaft has splined thereon a two-faced clutch member 78 engageable with a clutch face 79 formed on a gear 80 rotatably mounted upon the shaft 77 and meshed with a gear 81 secured upon the shaft 66 and engageable alternately with a clutch face 82 formed on the hub of a gear 83 having drive connection through an idler gear 84 with a gear 85 secured upon the shaft 66, so that with the shaft 66 rotating constantly in the same direction the shaft 77 and bevel gear 75 will be driven in one direction when the clutch member 78 is engaged with the clutch face of the gear 80 and in the opposite direction when the clutch member 78 is engaged with the clutch face of the gear 83.

For shifting the clutch member 78 it has connection through a two-armed lever 86 with a pair of solenoids 87, 88 which are interposed in respective electric circuits, that in which the solenoid 88 is mounted being adapted to be momentarily closed by a switch mechanism 89 having a trip member 90 adapted to be lifted by contact of

a dog 91 on the lower end of the slide bar 72 at the upper limit of the latter's movement, which energizes the solenoid 88 and shifts the clutch member 78 from the gear 83 to the gear 80 to stop the upward movement and effect the return, descending movement of the master form 70, the clutch faces remaining in engagement after the circuit is broken by descent of the dog 91 from the trip member 90.

The circuit in which the solenoid 87 is mounted is adapted to be momentarily closed by a trip member 92 which is mounted in position to be engaged by the dog 91 at the limit of the downward movement of the master form and its slide-bar mounting 72, which effects a closing of the circuit in which the solenoid 87 is mounted and thus reverses the movement of the master form, the clutch faces remaining in engagement after the circuit is reopened by movement of the dog upward from the trip member 92.

For controlling the range of the master form's vertical reciprocating movement the switch mechanism 89 and its trip member 90 are mounted on a vertical slide 93 formed on one edge with rack teeth meshed with a pinion 94 having a shaft 95 running to a suitable position for convenient manual raising or lowering of the slide 93 by manual rotation of the shaft 95.

The cam faces 29 and 36 are so formed as to maintain in front of each advancing weft-laying position a group of withdrawn pushers, as shown in Fig. 4, so that the pusher heads are not in position to interfere with the weft-laying and warp crossing operations, and to advance the pushers to the positions determined by the contact of the slide bars 27 with the master form 70 by progression, just behind the advancing weft-laying position, and thus to control the positioning of the newly laid weft lengthwise of the warp and consequently the relative lengths of material woven at different positions about the work.

The cam faces 41 and 41a are so formed as to effect a crossing of adjacent warps just after the passing of each advancing weft-laying position and preferably just after the adjacent pusher has arrived at its most advanced position.

Thus the vertical reciprocation of the master form results in the weaving of the tubular structure 16 to the form of a succession of upper-shaped portions each joined to an adjacent one at its smaller end and also at its larger end. Pull-off means (not shown) may be employed for lightly withdrawing the tubular structure from the weaving plane so that the work-manipulating members may operate unhindered, but the pull-off force preferably is sufficiently light to permit the shape of the woven structure to be determined solely or primarily by the action of the pushers and permissibly to some extent by the warp and weft tensions, although it is preferred to rely solely upon the pushers for the shape of the structure and to employ the tensions for control of the relative crimp of the warp and the weft.

The mechanism is adaptable for various types of weaving and for the production of striking color effects with suitable changes of warp or weft and obvious modifications of the style of weave.

The tubular structure 16 may be severed only at the positions of its largest size to obtain combined uppers and linings adapted to be incorporated in a shoe as shown in Figs. 8 and 9, or it may be severed at its largest and also at its smallest parts to produce one-ply uppers or one-ply linings.

The machine is highly automatic, and thus is economical of labor, and it also produces shaped shoe uppers, linings or the like and without waste of material.

Various modifications are possible within the scope of the invention as defined in the appended claims.

I claim:

1. The method of weaving a fabric to hollow form which comprises beating up the weft, as it is laid, to different determinate positions of substantial non-symmetry lengthwise of the warp in different regions of the fabric.

2. The method of weaving a tapered tubular fabric structure which comprises successively spreading in alternation two sets of circumferentially spaced warps, winding a weft into place between spreading operations, and causing the resulting tubular fabric to be of tapered form by beating up the weft, as it is laid, to progressively differing positions of substantial non-symmetry radially of the work.

3. The method of weaving a tapered tubular fabric structure which comprises successively spreading in alternation two sets of circumferentially spaced warps, winding a weft into place between spreading operations, and causing the resulting tubular fabric to be of tapered form by beating up the weft, as it is laid, to progressively differing positions radially of the work, the progression of the positions to which the weft is forced being different at different positions circumferentially of the work to give the resulting tube a non-symmetrical form with relation to its longitudinal axis.

4. The method of weaving a tapered tubular fabric structure which comprises successively spreading in alternation two sets of circumferentially spaced warps, winding a weft into place between spreading operations, and causing the resulting tubular fabric to be of tapered form by beating up the weft, as it is laid, to progressively differing positions of substantial non-symmetry radially of the work, the progression being periodically reversed in direction to give the tube an accordion-like form.

5. The method of weaving a tapered tubular fabric structure which comprises successively spreading in alternation two sets of circumferentially spaced warps, winding a weft into place between spreading operations, and causing the resulting tubular fabric to be of tapered form by beating up the weft, as it is laid, to progressively differing positions radially of the work, the progression of the positions to which the weft is forced being different at different positions circumferentially of the work to give the resulting tube a non-symmetrical form with relation to its longitudinal axis, and the progression being periodically reversed in direction to give the tube an accordion-like form.

6. Weaving apparatus comprising means for successively spreading in alternation two sets of warps, shuttle means for laying a weft between spreading operations, and means separate from the shuttle means for forcing the weft, as it is laid, to different positions of substantial non-symmetry lengthwise of the warp in different regions of the work.

7. Weaving apparatus comprising means for successively spreading in alternation two sets of circumferentially spaced warps, shuttle means for winding a weft into place between spreading oper-

ations, and means separate from the shuttle means for forcing the weft, as it is laid, to progressively differing positions of substantial non-symmetry radially of the work.

8. Weaving apparatus comprising means for successively spreading in alternation two sets of circumferentially spaced warps, shuttle means for winding a weft into place between spreading operations, and means separate from the shuttle means for forcing the weft, as it is laid, to positions radially of the work which progressively differ at different rates of progression lengthwise of the work at different positions circumferentially of the work whereby the work is given a substantially non-symmetrical form with relation to the axis of the weaving shed.

9. Weaving apparatus comprising means for successively spreading in alternation two sets of circumferentially spaced warps, shuttle means for winding a weft into place between spreading operations, and means separate from the shuttle means for forcing the weft, as it is laid, to progressively differing positions of substantial non-symmetry radially of the work with periodic reversal of the direction of the progression to give the work an accordion-like form.

10. Weaving apparatus comprising means for successively spreading in alternation two sets of circumferentially spaced warps, shuttle means for winding a weft into place between spreading operations, and means separate from the shuttle means for forcing the weft, as it is laid, to positions of substantial non-symmetry radially of the work which progressively differ at different rates of progression lengthwise of the work at different positions circumferentially of the work with periodic reversal of the direction of the progression to give the work an accordion-like form.

11. A method as defined in claim 4 including the severance of the tube into annular units.

12. A method as defined in claim 5 including the severance of the tube into annular units.

13. Weaving apparatus comprising means for successively spreading in alternation two sets of warps, means for laying a weft between spreading operations, a cam, means controlled by the cam for forcing the weft, as it is laid, to different positions of substantial non-symmetry lengthwise of the warp in different regions of the work, and means for driving all of the aforesaid means in timed relation.

14. Weaving apparatus comprising means for successively spreading in alternation two sets of circumferentially spaced warps means for winding a weft into place between spreading operations, a cam, means controlled by the cam for forcing the weft, as it is laid, to progressively differing positions of substantial non-symmetry radially of the work, and means for driving all of the aforesaid means in timed relation.

15. Weaving apparatus comprising means for successively spreading in alternation two sets of circumferentially spaced warps, means for winding a weft into place between spreading operations, a cam, means controlled by the cam for forcing the weft, as it is laid, to progressively differing positions radially of the work, and means for driving all of the aforesaid means in timed relation, said driving means including means for effecting periodic reversal of the direction of movement of the cam to give the work an accordionlike form.

16. Weaving apparatus comprising means for successively spreading in alternation two sets of circumferentially spaced warps, means for winding a weft into place between spreading operations, a cam, means controlled by the cam for forcing the weft, as it is laid, to progressively differing positions radially of the work, and means for driving all of the aforesaid means in timed relation, the cam being mounted for movement axially of the work and of non-symmetrical form with relation to all axes parallel to its direction of movement.

17. Weaving apparatus comprising means for successively spreading in alternation two sets of circumferentially spaced warps, means for winding a weft into place between spreading operations, a cam, and means controlled by the cam for forcing the weft, as it is laid, to progressively differing positions radially of the work, the last said means comprising a circumferential series of levers, weft-engaging means on each lever, means for actuating the levers, and means controlled by the cam for shifting the fulcrum points of the levers.

18. Weaving apparatus comprising two circumferential sets of vertically slidable warp-guiding and spreading members, vertical-axis annular cams for actuating said members, a circumferential series of substantially-vertical weft-placing levers, vertical-axis cam means for actuating said levers, and laterally extending weft-engaging push bars pivoted on said levers.

19. In combination with weaving instrumentalities, a weft-placing member formed with a guide groove in a lower face thereof to receive a warp for supporting and guiding of the member by the warp and with a weft-engaging face.

20. In combination with means for successively spreading in alternation two sets of circumferentially spaced warps, a circumferentially spaced set of weft-placing members, each member comprising a bar having a weft-engaging inner end-face and pivotally mounted at its outer end and adapted to engage a warp near its inner end and ride thereon, and means for reciprocating the pivot of the bar in the general direction of the length of the bar for beating up the weft.

21. The method of weaving a fabric of hollow form which comprises supporting only centrally and at radially remote positions two circumferential sets of radially disposed warps, spreading the sets of warps by alternation of the sets, winding a weft into place between spreading operations, and giving the resulting weave a substantial non-symmetry solely by beating-up each turn of the weft to substantially different radial positions at different circumferential positions.

22. Weaving apparatus comprising means for supporting only centrally two circumferential sets of radially disposed warps, means for supporting the warps only at positions radially remote from the central supporting means and for spreading the warps by alternation of the sets, means for winding a weft into place between spreading operations, and power driven means timed with the warp-spreading means for beating-up the weft to substantially different radial positions at different circumferential positions of the same turn of the weft, and in a region remote from local support of the warps.

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