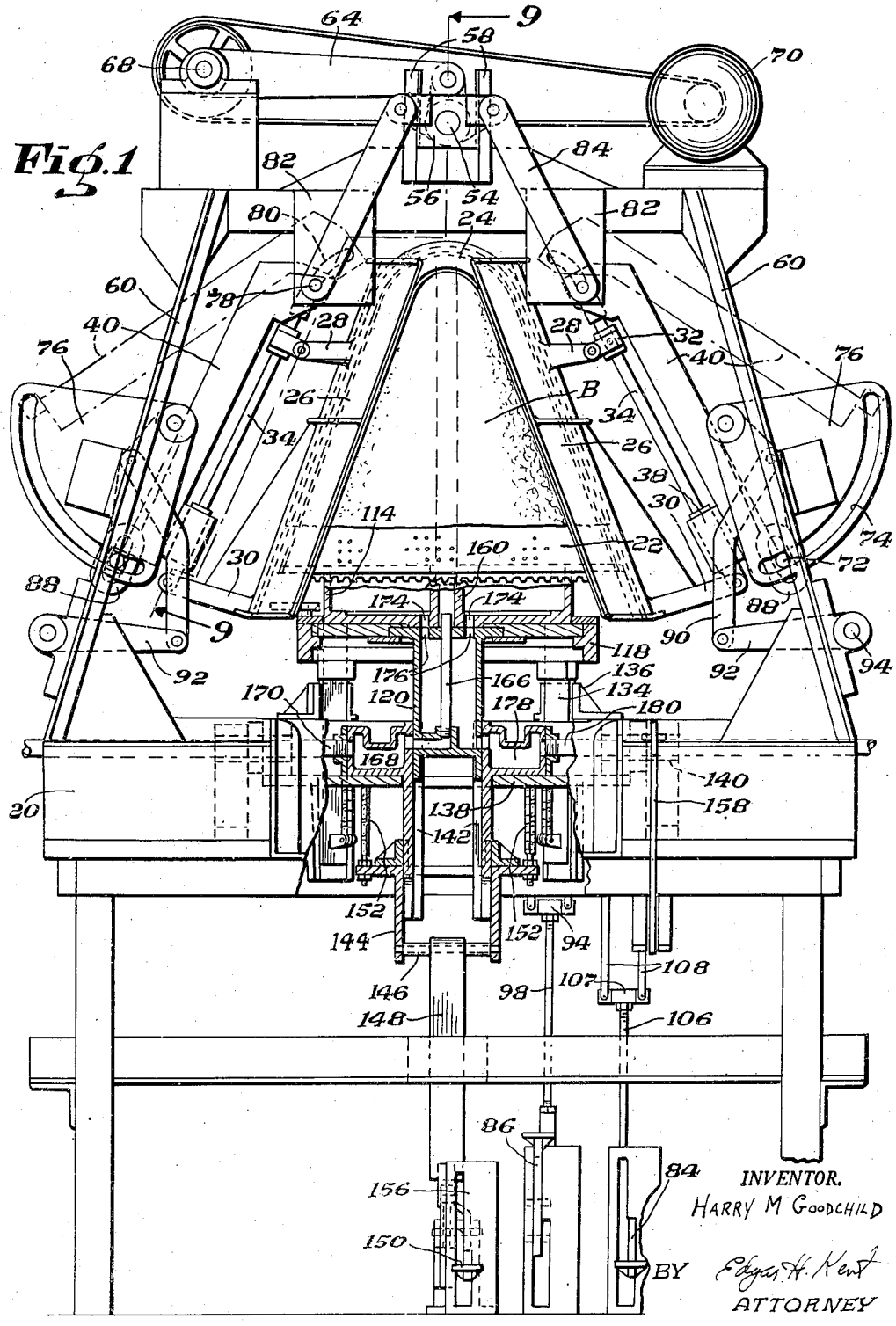
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FELT HARDENING MACHINE

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Fig. 1



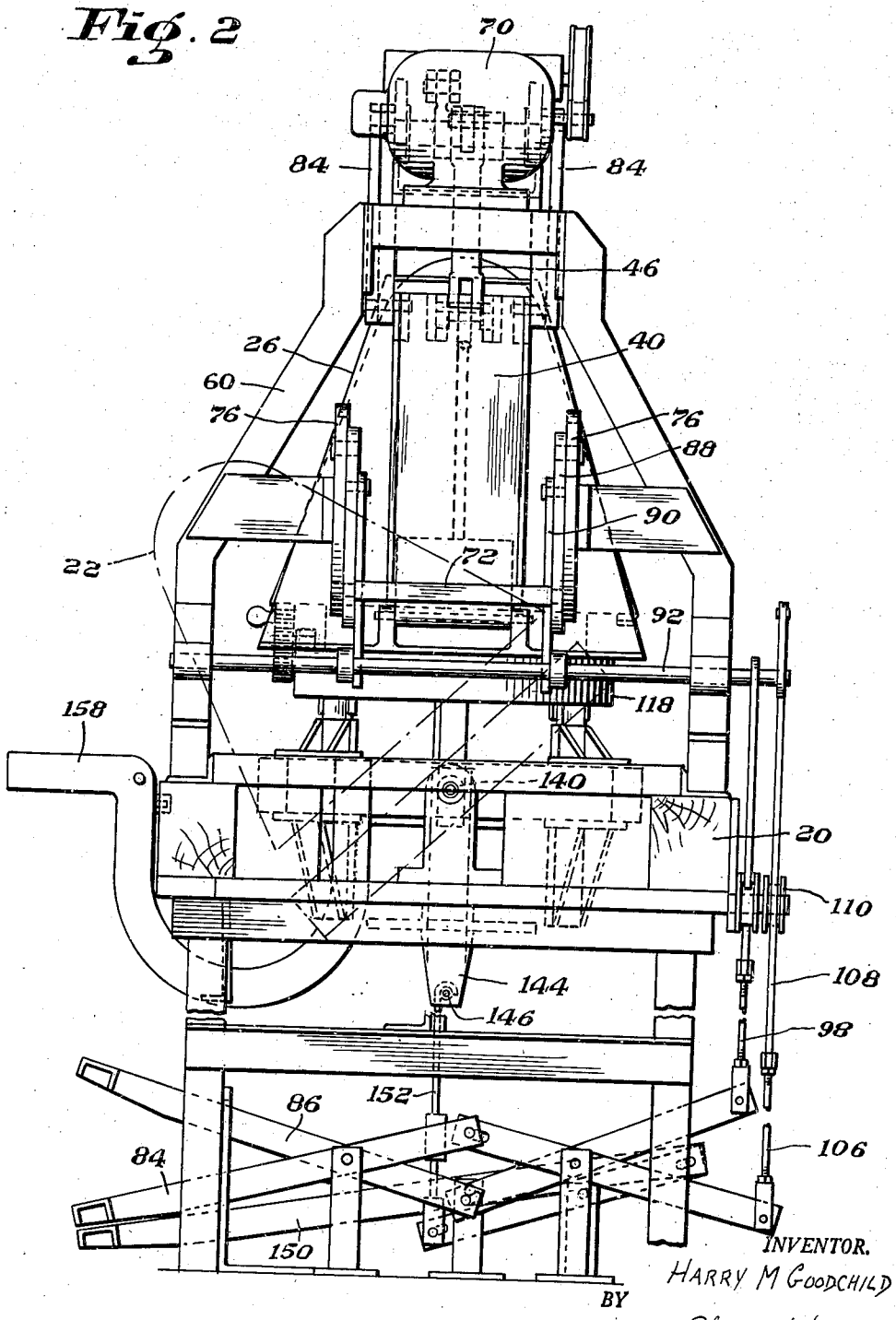
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Fig. 2




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Fig. 3

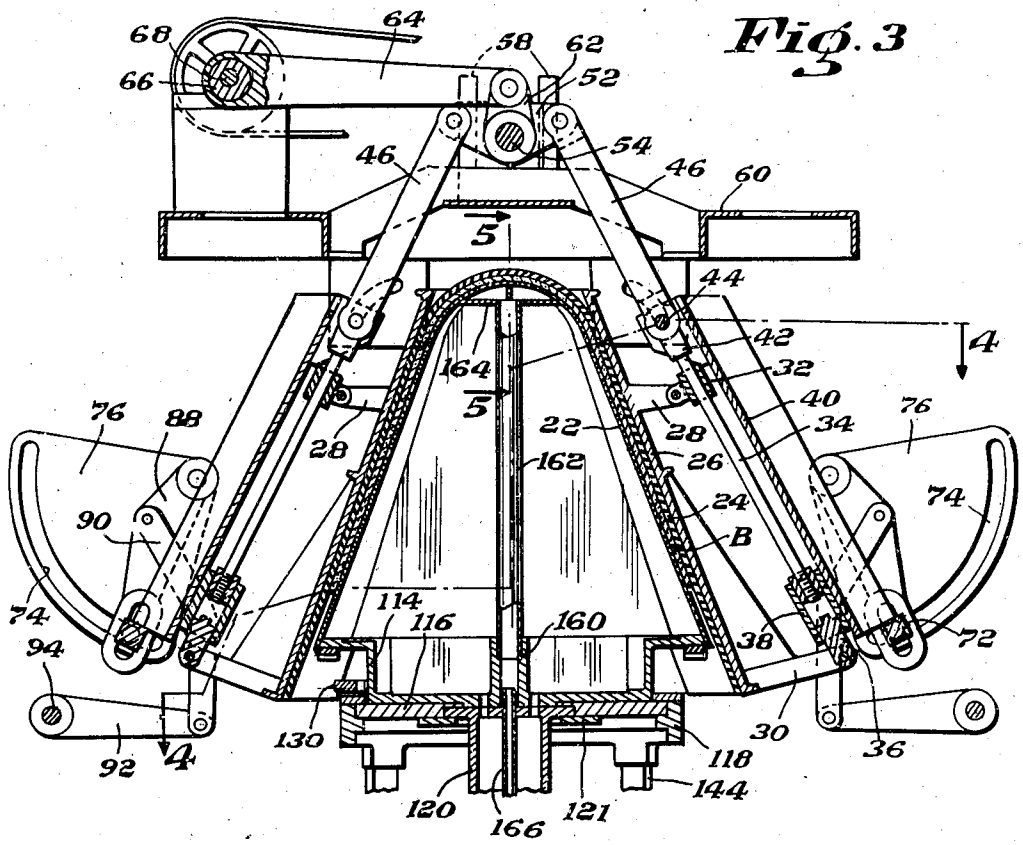



Fig. 4

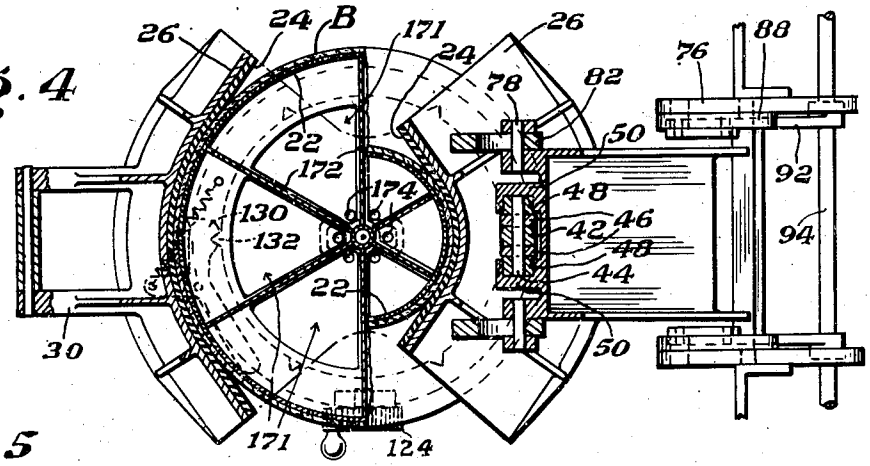



Fig. 5

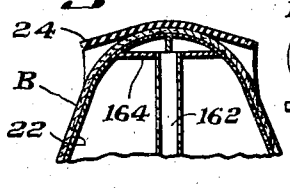
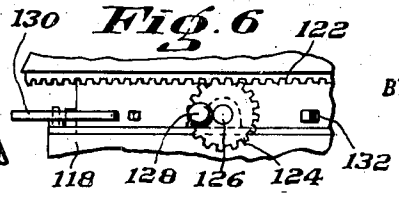



Fig. 6




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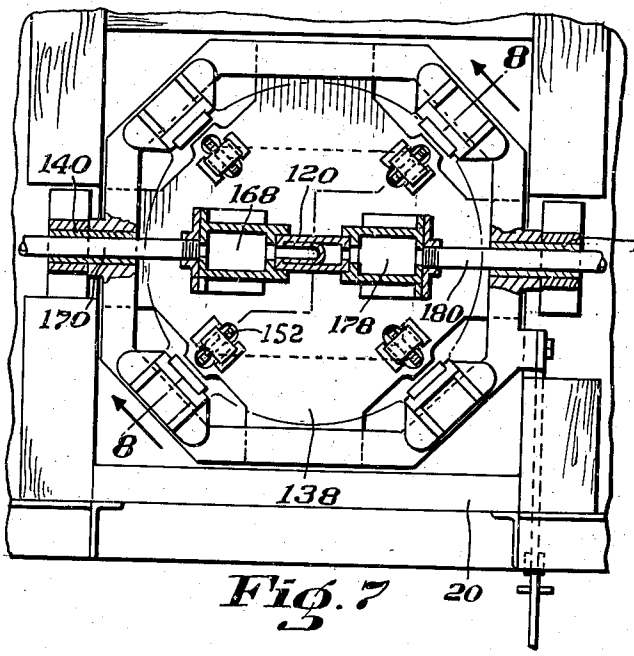



Fig. 7

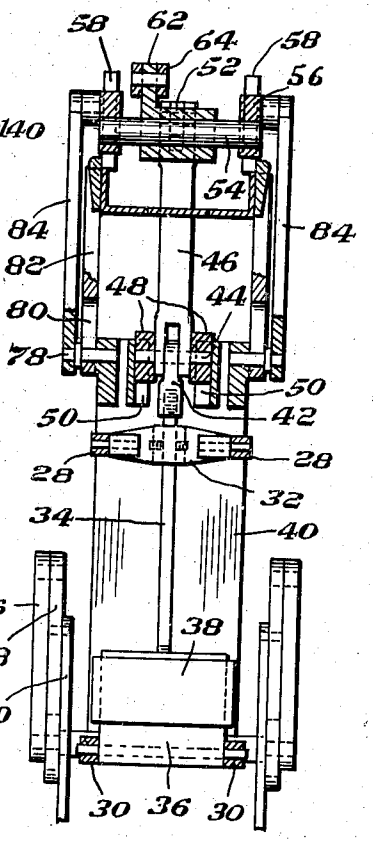



Fig. 9

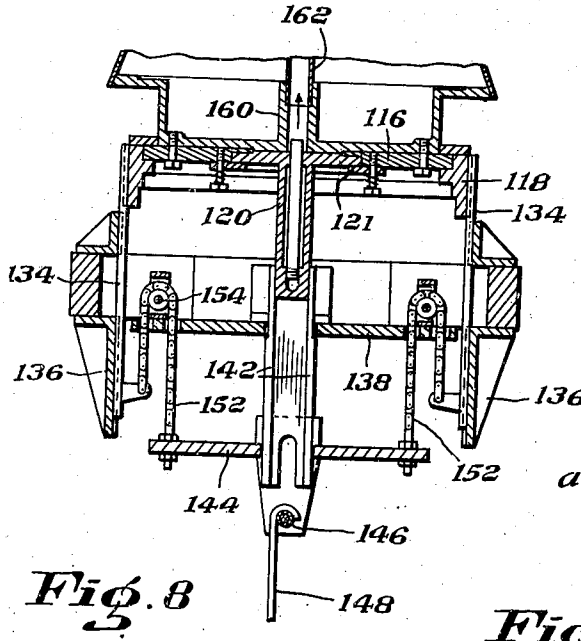



Fig. 8

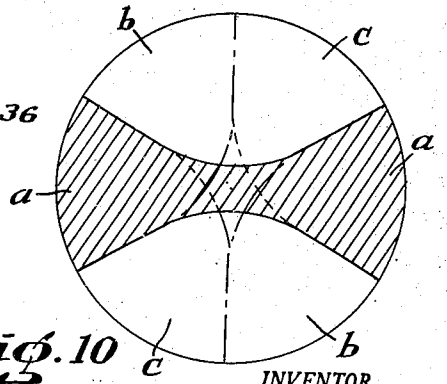



Fig. 10

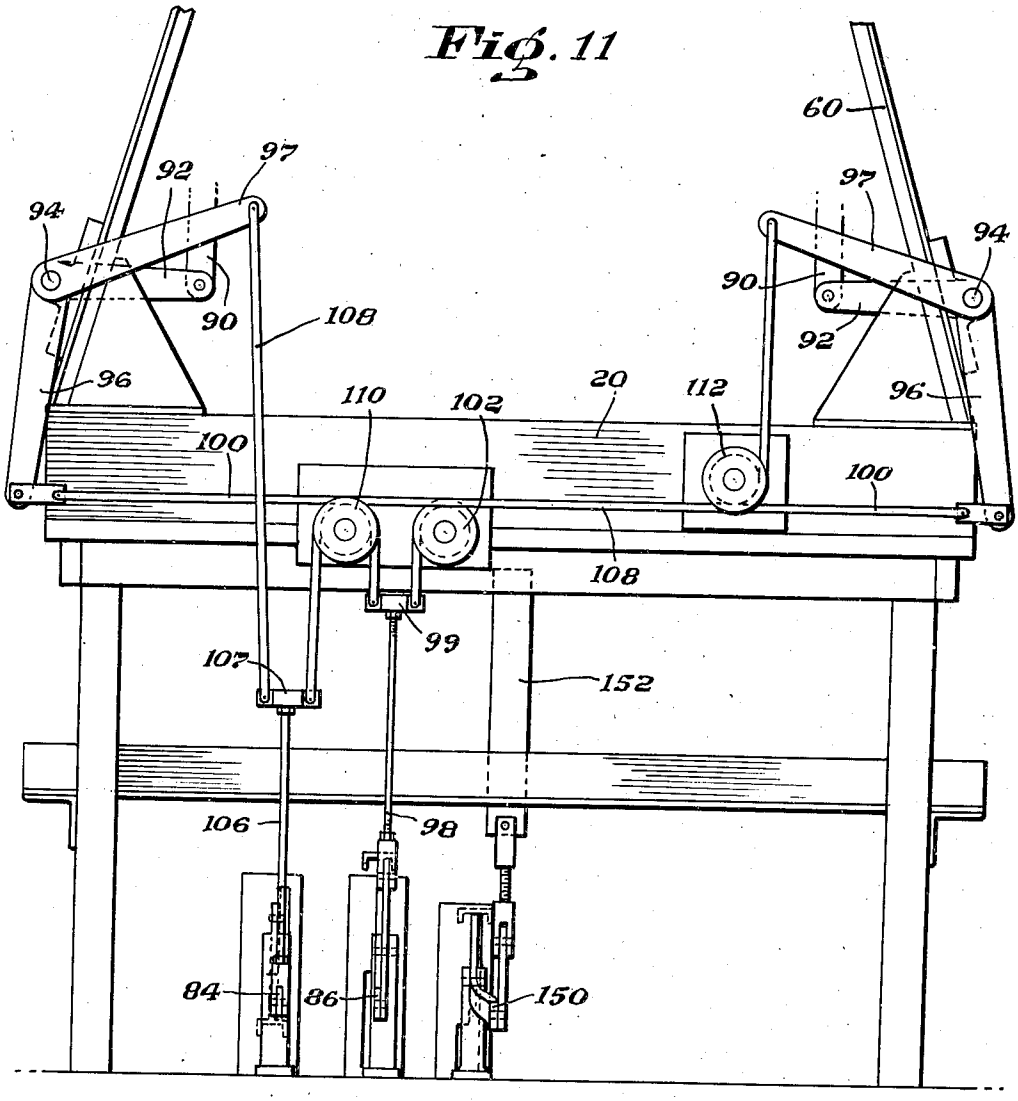
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Fig. 11



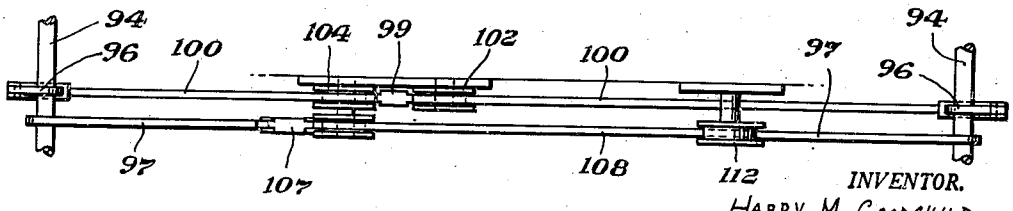




Fig. 12

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Patented Aug. 16, 1949

2,479,228

# UNITED STATES PATENT OFFICE

2,479,228

## FELT HARDENING MACHINE

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Application September 11, 1946, Serial No. 696,165

27 Claims. (Cl. 223—20)

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This invention relates to felt hardening machines and more particularly to a machine for hardening shaped felt bodies such as hat bodies.

Heretofore, such felt bodies have generally been hardened in the collapsed or flattened state in machines wherein the flattened bodies are pressed between oscillating hardening plates in the presence of steam. When hardened in the flattened state, the bodies tend to show crease marks at the sides unless frequently removed and rearranged during the treatment. Also, because they are flattened out of their natural form, the bodies tend to wrinkle, forming irregularities in the finished product. Only the outer surface of the body is operated upon by the hardening members and in order to prevent the opposite inner surfaces of the collapsed walls from felting and adhering together under the hardening action, it is the practice to insert a protective lining fabric into the body prior to the hardening operation and subsequently to remove the fabric therefrom.

For these reasons the hardening operation with such machines has been difficult, laborious and costly, calling for very considerable skill on the part of the machine operator and frequently productive of defectively hardened bodies. In addition, bodies with a rounded tip such as hat bodies require two such hardening operations on different machines, a side hardening operation on one machine and a tip hardening operation on a second machine.

An object of this invention is to provide a felt hardening machine wherein such shaped bodies are subjected to hardening while supported and maintained in their natural shape, thereby eliminating the troublesome wrinkling and creasing of the bodies which takes place when they are hardened in the flattened state.

Another object is to provide such a machine which is capable of simultaneously completely hardening both the tip and the sides of a hat body or the like uniformly and without removal of the partially hardened body from the machine for smoothing as has been necessary heretofore.

A further object is to provide such a machine wherein the inner and outer surfaces of the body walls are subjected simultaneously to hardening action, thereby increasing the speed and improving the quality of the hardening and also eliminating the fabric liner which has been required in flat hardening and the labor and expense involved in applying and removing the liner. Yet another object is to provide such a machine which requires less skill and is less costly to operate than prior machines but which produces a superior grade of hardening.

The foregoing and other objects and advantages of the invention will be more fully apparent from the ensuing particular description of the invention in conjunction with the appended drawings which illustrate a preferred embodiment of novel mechanisms of the invention arranged in a single machine for simultaneously hardening the tip and sides of a felt hat body.

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In the drawings:

Fig. 1 is a partial vertical section, partial side elevation of the machine;

Fig. 2 is an end elevation thereof;

Fig. 3 is a vertical section view of an upper portion of the machine as shown in Figs. 1 and 2;

Fig. 4 is a horizontal section view on the zigzag line 4—4 of Fig. 3;

Fig. 5 is a vertical section view on line 5—5 of Fig. 3;

Fig. 6 is a fragmentary detail view in side elevation of certain parts of the machine;

Fig. 7 is a detail view in plan of parts of the machine;

Fig. 8 is a vertical section view on line 8—8 of Fig. 7;

Fig. 9 is a detail view taken on line 9—9 of Fig. 1, looking in the direction of the arrows;

Fig. 10 is a diagrammatic plan view of the rounded tip of a hat body, illustrating by shading and by dot-dash lines the successive zones of hardening action of the machine on the tip;

Fig. 11 is a detail side elevation view of certain operating parts of the machine;

Fig. 12 is a plan view of the parts shown in Fig. 11.

Describing now the preferred embodiment of the invention shown in the accompanying drawings, and referring first to Fig. 1, the machine has a main frame in the form of a table 20 upon which is mounted by means hereinafter described an upstanding cone support 22 for the hat body B, shown mounted on the support in Figs. 1, 3 and 4. Support 22 is of generally conical shape with a rounded tip, its external shape and diameter corresponding closely to the inner shape and diameter of the hat body B to be hardened so that the latter fits tightly and smoothly thereon. Support 22 is shown formed of apertured metal and is provided with an external rough hardening surface. In the illustrated machine, this hardening surface is the roughened metal surface of the support itself, which may be suitably roughened by sand or shot blasting, but if desired, the support may be covered with a fabric or other suitable porous hardening material. The rough surfaced support constitutes an inner hardening member for both the conical side and the rounded tip of the hat body, as will hereinafter appear.

Cooperating with the support and inner hardening member 22 is an outer hardening member 24 (Figs. 1, 3 and 4) which, as shown, is in the form of a molded flexible belt having a rough inner hardening surface. Belt 24 is of inverted U-shape fitting closely over support 22, extending

from tip to base thereof at opposite sides of the longitudinal axis of the support and extending partially about said axis. As shown in Fig. 4 the outer hardening member or belt **24** is curved transversely, the intermediate portion of this transverse curvature corresponding to the curvature of the contiguous portion of the support **22**. Thus, the transverse curvature of the mid-portion of the hardening belt opposite the tip of the support is approximately spherical about the center of the spherically curved support tip, while the two side portions of the belt are approximately conically curved at their mid-section about the support axis in conformity with the curvature of the rest of the support.

Referring further to Fig. 4, it will be seen that the side portions of belt **24** are transversely curved at increasing radius from the support axis so that they incline away from the surface of the support. Also, the angular extent of the transversely curved mid-portion of the belt about the support axis is approximately uniform from adjacent the mid point of the tip to the base. In the instance shown, this angular width is approximately 60°. Since the belt engages opposite sides of the hat body, the total angular width of the latter which it engages is 120°. Belt **24** is preferably of moldable rubber and fabric composition or of rubber with an inner facing of fabric but may be of any suitable flexible material.

Referring again to Figs. 1, 3 and 4, the portions of the hardening belt **24** at opposite sides of the support tip are fastened on their outer surfaces to correspondingly transversely curved plates **26**. Projecting from the outer surfaces of plates **26** are upper and lower pairs of opposite arms **28**, **30**. The outer ends of arms **28** are pivotally connected to the ends of a cross strap **32** fixed to a rod **34** extending longitudinally of the plate **26** (Figs. 1, 3 and 9). The arms **30** are pivotally connected to the lower end of a block **36** the upper end of which is fixed to the lower end of rod **34** and which is slidable longitudinally of the plate **26** in a guideway **38** projecting from a supporting frame member **40** (Figs. 1, 3 and 9).

The upper end of rod **34** is fixed to a collar member **42** (see particularly Fig. 9) pivotally connected by a pin **44** to the lower bifurcated end of a lever **46**, the pin **44** extending through the end of lever **46** and being fixedly connected to a pair of blocks **48** slidable longitudinally of plate **26** in ways **50** projecting from the under surface of the plate. The upper ends of levers **46** are pivotally connected to the opposite ends of a crank **52** (Fig. 3) which is pivotally mounted at its mid portion on a rock shaft **54** the ends of which are fixedly mounted in blocks **56** (Figs. 1 and 9) which are vertically slidable (for a purpose hereinafter explained) on standards **58** fixedly mounted above the support **22** on a frame **60** rising from table **20**. An arm **62** integral with crank **52** is pivotally connected to one end of a crank arm **64** the opposite end of which rotatably receives an eccentric **66** on a shaft **68** rotatably mounted on frame **60**. Shaft **68** is rotated by belt and pulley connection to a motor **70** also mounted on frame **60**.

The rotation of shaft **68** by motor **70**, through eccentric **66** and crank arm **64**, rocks crank **52** so that levers **46** are alternately oppositely raised and lowered a small amount. This motion is imparted to plates **26** through the longitudinal reciprocation of rods **34** with respect to members **40** (held stationary by means hereinafter described) and by means of arms **28**, **30** so that the plates are oscillated toward and from the top of the support **22** oppositely, the plate at one side of the support moving up while the opposite plate moves down. The hardening belt **24**, which is attached to plates **26**, therefore, oscillates with them longitudinally parallel to the surface of support **22** and in contact with the outer surface of a hat body thereon. By reason of its flexibility, the portion of the belt extending between plates **26** over the rounded tip of the support **22** is maintained under pressure against the tip during the oscillation, this portion of the belt oscillating approximately about an axis normal to the axis of the support and extending through the center of curvature of the spherical end of the support.



The relative oscillation of the hardening member **24** and support **22** effects hardening action on the segments of the hat body engaged between the opposed hardening surfaces of member **24** and support **22**. The action is facilitated by passing steam into the felt as it is rubbed between the hardening surfaces, the steam applying means being described subsequently herein.

Since hardening belt **24** extends only partially about the periphery of the support, it is necessary, once the hardening action has been completed on the segmental portions of the side and tip of the hat body engaged by the belt to relatively move the hardener belt and the hat body about the longitudinal axis of the body and support to present a fresh area of the body between the hardening surfaces of the support and belt. In the machine shown, this is accomplished by first bodily moving the hardening belt out of engagement with the hat body on the support and then rotating the support about its longitudinal axis the requisite amount, by means now to be described.

Referring to Figs. 1 to 4 and 9 it will be seen that the lower end of each member **40** is provided with a transverse cross bar **72** having reduced projecting ends each of which extends through a slot **74** in a vertically disposed segmental support member **76** fixed to frame **60**. Slot **74** is curved in a vertical plane, its upper end being nearer to the upper end of member **40** in the full line position of the latter in Fig. 1. The upper ends of members **40** are provided with laterally projecting pins **78** (Fig. 4) which extend through slots **80** in vertical supports **82** depending from the upper part of framework **60** at either side of the members **40**. Slots **80** are vertically disposed and curve upwardly and toward the axis of support **22** from their lower ends.

The outer ends of the pins **78** of each member **40** are rotatably fastened to arms **84** which extend upwardly and are pivotally connected at their upper ends to blocks **56** which, as previously described, form the end mountings for rock shaft **54** and are vertically slidable on standards **58**.

When the reduced ends of bars **72** are slid upwardly in slots **74**, they approach the lower ends of slots **80** causing pins **78** to slide upwardly along said slots and bearings **56** are slid upwardly on standards **58** by arms **84** in correspondence with the upward movement of pins **78**, crank arm **64** pivoting on its connections to arm **62** and shaft **68** to permit this movement. Members **40** are thereby brought to their raised position shown in dotted lines in Fig. 1. Plates **26** are correspondingly moved away from support **22** by their connections to members **40** carrying hardener belt **24** clear of the support and out of contact with the hat body thereon, both at the sides and over the tip, the relative tilting of the members **40** during this movement, as indicated by the dotted lines in

Fig. 1, and of the parts connected thereto, being permitted by outward flexing of the belt adjacent the mid point of the tip of support 22.

Means are provided for raising and lowering the members 40 and connected parts by manipulation of a pair of foot pedals 84, 86. Referring to Figs. 1, 2, 3, 11 and 12, each of the supports 76 has pivoted thereto a lever 88 having a slotted end which embraces the contiguous reduced end of cross bar 72 on member 40. Levers 90 are pivoted at one end to lever 88 and at the other end to one end of levers 92 fixed to a shaft 94 rotatably mounted on frame 60. Bell crank levers on each of the shafts 94 have their depending arms 96 connected to rod 98 on foot pedal 86 by cords 100 secured at one end to said arms, passing over pulleys 102, 104 on frame 20, and attached at the opposite end to a lug 99 in the end of rod 98 (Figs. 11, 12). The other, upper arms 97 of the bell cranks are connected to a rod 106 on pedal 84 by cords 108 fastened at opposite ends to said arm and to a lug 107 on rod 106, one of said cords (on the right in Figs. 11 and 12) passing over a guide pulley 110 and under a second guide pulley 112 on frame 20.

When the hardening belt member is in its lowered position, pedal 84 is in its lowermost position and pedal 86 is in its uppermost position as shown in the drawings. By depressing pedal 86 arms 96 of the bell cranks are drawn inwardly toward one another through cords 100 oppositely rotating the two shafts 94 in the direction to raise arms 92, levers 90 and arms 97. The raising of levers 90 pivots levers 88 in the direction to move bar 72 upwardly in slot 74 to the raised position of members 40 shown in dotted lines in Fig. 1, and the raising of arms 97 of the bell cranks lifts pedal 84 to its upper position through connecting cords 108. The system is balanced so that members 40 and connected parts remain in their upper position until lowered by depression of pedal 84, reversing the movement of parts just described.

When the hardening member 24 is in its raised position, support 22 is freed for rotation about its longitudinal axis to present a fresh area of the hat body to member 24 for hardening. To this end, member 22 is provided with an annular base 114 to the base of which is bolted a plate 116 rotatably seated on an annular member 118 (Figs. 1 and 8). Plate 116 is provided with a central aperture which relatively rotatably receives the edge of the top flange of a tubular member 120 held against longitudinal motion relative to plate 116 by a retaining ring 121. A ring gear 122 provided on the base of support 22 is engaged by a vertically disposed gear wheel 124 fixed to a shaft 126 rotatably mounted on member 118 (Figs. 4 and 6). Gear wheel 124 is rotated by a handle 128 to rotate support 22.

Also pivoted on member 118 is a latch member 130 the notched head of which is spring urged to a position of engagement with teeth 132 projecting laterally from base 114 of support 22. Teeth 132 are uniformly spaced about the axis of support 22 a distance equal to the angular width of the hardener member 24 and in the machine shown there are, therefore, six teeth 132 spaced 60° apart.

When the hardening operation has been completed on the portion of the hat body on support 22 engaged by member 24, said member is raised as above described. Latch 130 is then pivoted by hand in the counterclockwise direction as shown in Fig. 4 to release it from a tooth 132. Wheel 124 is then rotated to turn support 22 until the next tooth 132 reaches and is engaged by the latch. As above noted, the angular extent of this turn will be 60°, equal to the angular width of the hat body segments previously hardened and presenting the contiguous fresh area of the hat body to the member 24 which is then lowered and again operated to harden the second portion of the hat body. A second turn of support 22 presents the last third of the hat body surface to member 24 for hardening, after which the completely hardened hat body is ready for removal.



To facilitate application of the hat bodies to support 22 and their removal, means are provided for lowering the support from its full line position shown in the drawings and for tipping it forwardly as shown by dotted lines in Fig. 2. Referring to Fig. 1, member 118 is provided with depending legs 134 vertically slidable in guides 136 fixed to a frame 138 which is tiltably mounted in trunnions 140 on table 26. Tubular member 120 is vertically slidable between guides 142 also fixed to frame 138. A sleeve 144 is vertically slidable on the outer surface of guides 142 and has at its base a cross bar 146 engaged by a hook 148 on a foot pedal 150. A plurality of chains 152 are attached at one end to sleeve 144, extending upwardly therefrom over pulleys 154 on frame 138 and again downwardly with their opposite ends attached to the legs 134 (Figs. 1 and 8).

When support 22 is in its raised position shown in Fig. 1, pedal 150 is lowered and caught under a latching projection in its guide plate 156. By swinging the pedal to the left in said figure, it is freed from the latch and member 118 with support 22 which it carries is freed to slide downwardly under its own weight, legs 134 sliding downwardly in guides 136 and member 120 sliding downwardly in guides 142. The downward sliding of legs 134 pulls down the ends of chains 152 attached thereto raising their opposite ends and the sleeve 144 attached thereto and also raising pedal 150 by means of hook 148 engaged with bar 146. When the support 22 has thus arrived at its lowered position, frame 138 is tilted about trunnions 140 by means of a hand lever 158 (Fig. 2) to tilt support 22 forwardly as indicated by dotted lines in Fig. 2, cross bar 146 sliding out from under hook 148. In this position the hardened hat body is readily removed from the support 22 and a fresh hat body is applied. The support is then tilted back to its vertical position wherein bar 146 is reengaged with hook 148, and pedal 150 is depressed drawing sleeve 144 down and raising member 118 and support 22 through the upward pull of chains 152 on legs 134. Pedal 150 is now latched to maintain the parts in raised, hardening position until the hardening operation has been completed.

As previously stated, means are provided for supplying steam to the felt during the hardening action of the machine thereon and in the machine shown the steam is fed from the interior of support 22 through the porous wall thereof into the felt. Referring particularly to Figs. 1, 3, and 4, base 114 of support 22 is provided with an upstanding hollow hub 160 in which is fitted a pipe 162 extending upwardly to near the top of the cone. A flange 164 on the top of pipe 162 is fastened to the inner wall of the support 22 and forms above it a small chamber at the top portion of the rounded tip of the cone. A pipe 166 is fitted at one end in the lower end of hub 160, extends downwardly in member 120 and communicates with a steam compartment 168

provided in frame 138 through registering ports in member 120 and compartment 168. Compartment 168 is continuously supplied with steam by means of pipe 170 extending from the compartment axially through one of the trunnions 140 and to a source (not shown) of steam under pressure. Steam thus flows continuously through pipes 166 and 162 into the chamber above flange 164 and through the tip of support 22 into the tip of the hat body during the hardening operation.

The interior of support 22 below flange 164 is divided into six segmental compartments 171 of equal size by vertical partitions 172 (Figs. 3 and 4) connected to pipe 162, flange 164, the inner wall of support 22 and its base 114. These compartments have an angular width of 60°, equal to the angular width of the hardening area of hardener belt 24 and teeth 132 are so arranged with reference to partitions 172 that opposite pairs of said compartments register substantially exactly with the hardening mid portion of belt 24 at each turn of the support 22, as indicated in Fig. 4. Base 114 is provided with ports 174, one in each compartment 171, opposite pairs of which register with ports 176 in the upper end of member 120 when their compartments are opposite the hardener member 24. Steam is fed into member 120 from a compartment 178 in frame 138 through connecting ports, compartment 178 being continuously supplied with steam under pressure from a suitable source (not shown) by a pipe 180 extending axially through a trunnion 140.

Thus, during a hardening operation, steam flows only into the two compartments 171 which are opposite hardener member 24 and whose ports 174 are, therefore, in registry with ports 176. The steam is thereby directed entirely into the areas of the hat body undergoing hardening action at any given time.

It will be noted that when the support 22 is lowered on completion of the hardening operation, the downward movement of member 120 moves its ports out of registry with the corresponding ports in compartments 168 and 178 and seals the latter ports, so that all flow of steam to the interior of support 22 is automatically cut off until the support is again raised to hardening position, as is desirable. The provision of a separate steam supply line to the extreme tip of the support 22 has been found desirable in practice since this area of the hat body is difficult to harden properly and may require different conditions of steam than the sides. For the same reason, the angular width of the effective hardening area of the hardener belt portion opposite this extreme tip portion is made greater than 60° to provide for extra hardening action on this portion of the hat body. This is illustrated by Fig. 10, wherein the shaded area *a* indicates the zone of hardening engagement of member 24 with the tip of the hat body. This zone increases in angular width at the extreme top so that at each of the two other positions of the support 22, as indicated at *b* and *c*, this top portion continues to receive hardening action.

The increasing radius of transverse curvature of the hardener belt 24 at either side of the hardening zone thereof, as shown in Figs. 4 and 5, provides diminishing contact at the sides of the segment being hardened and prevents the formation of lines between successively hardened areas.

The operation of the machine has been sufficiently explained in the foregoing description. Because the hardening action of the machine is exerted simultaneously on the opposite surfaces of the felt and produces no wrinkles and creases in the felt, it is superior in quality as well as much quicker than that of the prior flat plate machines. The hardening produced in a given time is uniform and the machine may, therefore, be operated upon the successive segments of the hat body for predetermined uniform time intervals, whereas with the flat machines the hardening action is not uniform with time and has to be gauged by the operator with frequent opening of the machine and shifting and smoothing of the body. Thus the high degree of skill heretofore needed for the hardening operation is rendered unnecessary, as the operation of the machine is a routine matter, readily performed by unskilled labor. Since the tip and side of a hat body are simultaneously hardened, the machine eliminates one of two hardening operations and machines heretofore required for hardening hat bodies.

While the novel mechanisms of the invention have been particularly described as organized in a single machine for completely hardening hat bodies, it will be readily appreciated that they may be applied in like form to the hardening of other shaped felt bodies of similar nature or to hardening only the side or tip of hat bodies if that be desired. It will also be understood that the form and arrangement of parts as shown and described is preferred only and that numerous changes may be made therein within the spirit and scope of the invention.

Having now particularly shown and described a preferred embodiment of the invention, what I desire to claim and secure by Letters Patent is:

1. A machine for hardening a wall of a hollow felt body which includes opposed hardening members relatively movable to and away from a hardening position of mutual engagement with the opposite surfaces of a segment of the felt body wall, means for relatively oscillating said members while in said hardening position to effect hardening of said body wall segment engaged between said members, means for relatively moving said members to and away from said hardening position and means for effecting relative rotation of said body and one of said members about the longitudinal axis of said body while said members are relatively moved away from said hardening position to present a fresh segment of said body wall between said members for hardening.

2. A machine as claimed in claim 1 wherein said relative oscillation of said members takes place longitudinally of said body wall.

3. A machine as claimed in claim 1 wherein at least one of said members has a steam-pervious hardening surface and which includes means for passing steam through said surface into the felt.

4. A machine as claimed in claim 1 arranged for hardening a said felt body having a conical base and rounded tip wherein said segment of said body wall engaged between said members extends from the lower edge of the base to the mid-point of the tip of said body.

5. A machine for hardening a wall of a hollow felt body which includes a support member adapted to fit coaxially within and support said body wall, said support member having a hardening surface engaging the inner surface of said wall, a hardening member having a hardening surface engageable with a segment of said wall of the body on said support member, means for relatively moving said members to and away from

a hardening position of mutual engagement of their hardening surfaces with said wall, means for relatively oscillating said members substantially parallel to their opposed hardening surfaces while in said hardening position to effect hardening of the body wall segment engaged by the opposed hardening surfaces of said members, and means for relatively rotating said members about the axis of said support member while said members are relatively moved away from said hardening position to present a fresh segment of the wall between said members for hardening.

6. A machine as claimed in claim 5 arranged for hardening a conically curved wall of a hollow felt body wherein said hardening surface of said support member has a substantially conical curvature and said hardening surface of said hardening member has a concave conical curvature substantially coaxial with said support member in the hardening position of said members.

7. A machine as claimed in claim 5 arranged for hardening a spherically curved wall of a hollow felt body wherein said hardening surface of said support member has a substantially spherical curvature and said hardening surface of said hardening member has a concave spherical curvature substantially concentric with said hardening surface of said support in the hardening position of said members.

8. A machine as claimed in claim 5 wherein one of said hardening members is steam pervious and which includes means for passing steam through said surface into the felt portion engaged thereby when in hardening position.

9. A machine for hardening a conical wall of a hollow felt body which includes a conical support adapted to fit snugly, coaxially within said wall, a hardening surface on said support engaging the inner surface of said wall, a hardener member movable to and away from a hardening position of engagement with the outer surface of a segment of said body wall on said support of substantially uniform angular width about the longitudinal axis of said support, means for relatively oscillating said support and said member longitudinally of said support axis and substantially parallel to their opposed surfaces when said member is in said hardening position, and means by which said support and said member are mounted for relative rotation about the axis of said support to present different segments of said wall to said member for hardening.

10. A machine as claimed in claim 9 which includes means for moving said hardener member to and away from said hardening position and means for relatively rotating said support and said member about said axis through an angle equal to the angular width of said body wall segment while said member is moved away from said hardening position.

11. A machine as claimed in claim 9 wherein said hardener member includes opposed portions engageable with segments of said body wall at opposite sides of the longitudinal axis of said support.

12. A machine for hardening a spherically curved wall of a hollow felt body which includes a support having a substantially spherically curved hardening surface adapted to fit snugly concentrically within said wall, a hardener member movable to and away from a hardening position of engagement with a segment of said body wall on said support of substantially uniform angular width about the longitudinal axis of said support from the base to adjacent the mid-point of said wall, means for relatively oscillating said support and said member about an axis substantially normal to the longitudinal axis of said support and extending approximately through the center of curvature of said hardening surface of said support, and means by which said support and said member are mounted for relative rotation about the longitudinal axis of said support to present different segments of said wall to said member for hardening.



13. A machine as claimed in claim 12 which includes means for moving said hardener member to and away from said hardening position and means for relatively rotating said support and said member about said support axis through an angle equal to the angular width of said body wall segment while said member is moved away from said hardening position.

14. A machine as claimed in claim 12 wherein said hardener member includes opposed portions engageable with segments of said body wall at opposite sides of the longitudinal axis of said support.

15. In a machine for hardening a hollow felt body which includes a support member adapted to fit coaxially within and support the body wall, a hardener member arranged for hardening engagement with the outer surface of a segment of the body wall on said support, said member having a concave hardening surface opposed to said support and extending only partially about the longitudinal axis of the support, said hardening surface having a cross-sectional curvature of constant radius about said axis at its mid-portion and of increasing radius about said axis from said mid-portion toward the side edges thereof.

16. A machine as claimed in claim 15 wherein said mid-portion of said hardening surface is of substantially uniform angular width about said axis.

17. A machine for hardening hollow felt bodies which includes a support having a conical base and rounded tip adapted to fit snugly within and support a correspondingly shaped felt body, a hardening surface on said support, hardener means having hardening surfaces arranged for hardening engagement with the outer surfaces respectively of a segment of the conical base portion and with a segment of the rounded tip portion of the body wall on said support, said segments extending the full length of said respective portions of the body wall, means for relatively moving said hardener means and said support to and away from a position of hardening engagement of said surfaces of said hardener means with said body wall segments, means for relatively oscillating said support and hardener means to effect hardening of said segments, and means for relatively rotating said support and said hardener means about the longitudinal axis of said support while said support and hardener means are relatively moved away from said position to present fresh segments of said portions of the body wall to said hardener means for hardening.

18. A machine as claimed in claim 17 wherein said segment of said conical base portion of the body wall is of substantially uniform angular width about the longitudinal axis of said support.

19. A machine as claimed in claim 17 wherein said hardener means are movable by said moving means to and from said position of harden-

ing engagement with said body wall segments.

20. A machine as claimed in claim 17 wherein said relative oscillation of said support and said hardener means takes place longitudinally of said body wall segments and parallel to the opposed hardening surfaces of said hardener means and said support.

21. A machine as claimed in claim 17 wherein said support is rotated by said means for relatively rotating said support and hardening means.

22. A machine as claimed in claim 17 wherein said support and said hardener means are relatively movable to and from a second position in which said support is exposed for application of felt bodies to said support and for their removal.

23. A machine as claimed in claim 17 wherein said support and said hardener means are relatively tiltable about an axis transverse to the longitudinal axis of said support to expose said support for application and removal of felt bodies.

24. A machine as claimed in claim 17 wherein at least one of the opposed hardening surfaces engaging each of said body wall segments is steam-pervious and which includes means for passing steam through said surface into said body wall segment during hardening thereof.

25. A machine for hardening a spherically curved wall of a hollow felt body which includes two hardener members having opposed respectively convex and concave substantially spherically curved hardening surfaces engageable substantially concentrically with the inner and outer surfaces of a segment of said wall, and means for relatively oscillating said members about an axis extending approximately through the center of curvature of said wall.

26. A machine for hardening a conically curved wall of a hollow felt body which includes two hardener members having opposed respectively convex and concave substantially conically curved hardening surfaces engageable substantially coaxially with the inner and outer surfaces of a segment of said wall, and means for relatively oscillating said members parallel to their opposed hardening surfaces and longitudinally of the longitudinal axis of said wall.



27. A machine for hardening a hollow felt body having a conical base and rounded tip which includes hardener means comprising opposed respectively convex and concave substantially spherically curved hardening surfaces engageable substantially concentrically with the inner and outer surfaces of a segment of a said rounded tip of a said body and a pair of opposed respectively convex and concave substantially conically curved hardening surfaces engageable substantially coaxially with the inner and outer surfaces of a segment of said conical base of a said body and means for relatively oscillating said first named pair of hardening surfaces about an axis extending approximately through the center of curvature of said rounded tip of a said body and for relatively oscillating said second named pair of surfaces in parallel and longitudinally of the longitudinal axis of a said body.

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