Dec. 18, 1934. R. K. REYNOLDS 1,984,700

FELTING MACHINE

Filed Dec. 23, 1931 6 Sheets-Sheet 1

Fig. 1.

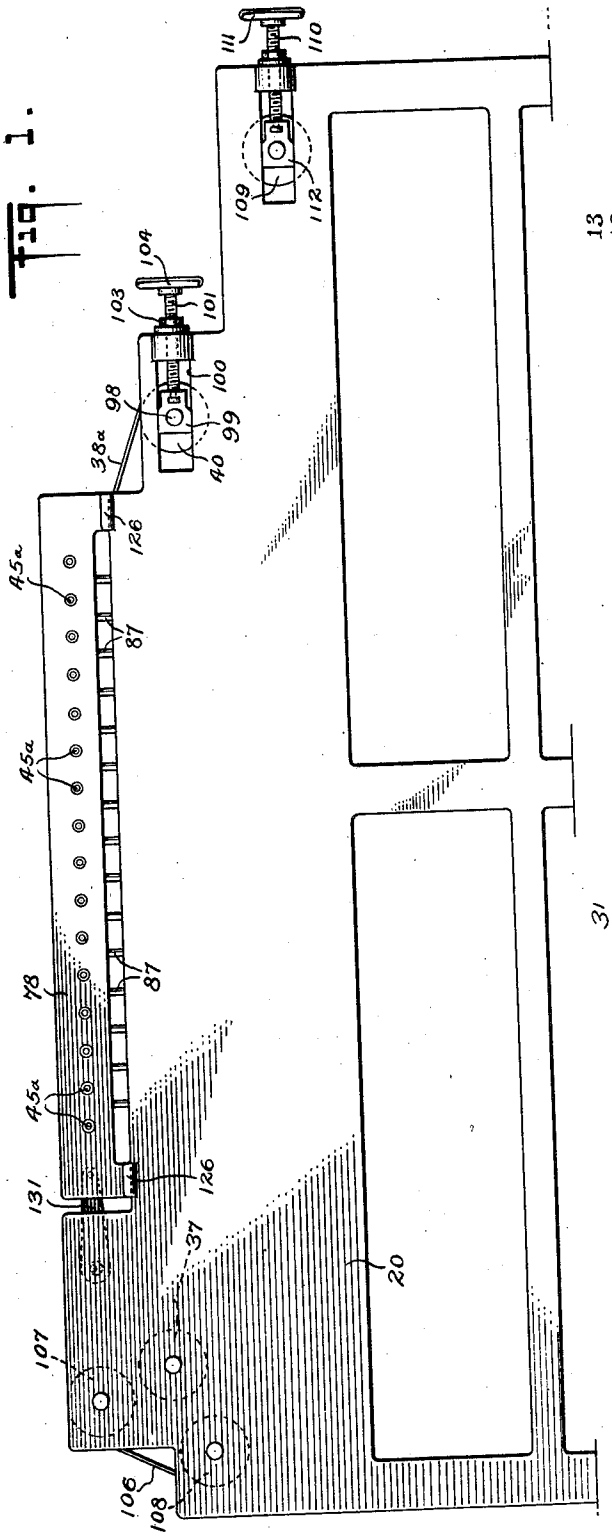


Fig. 3.

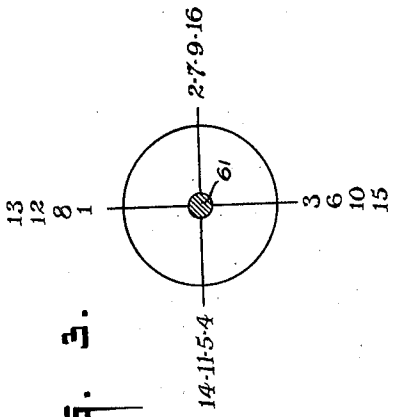
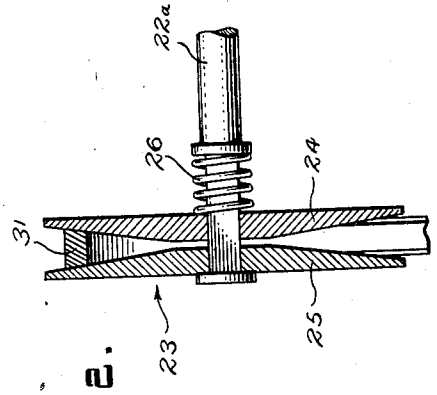


Fig. 2.



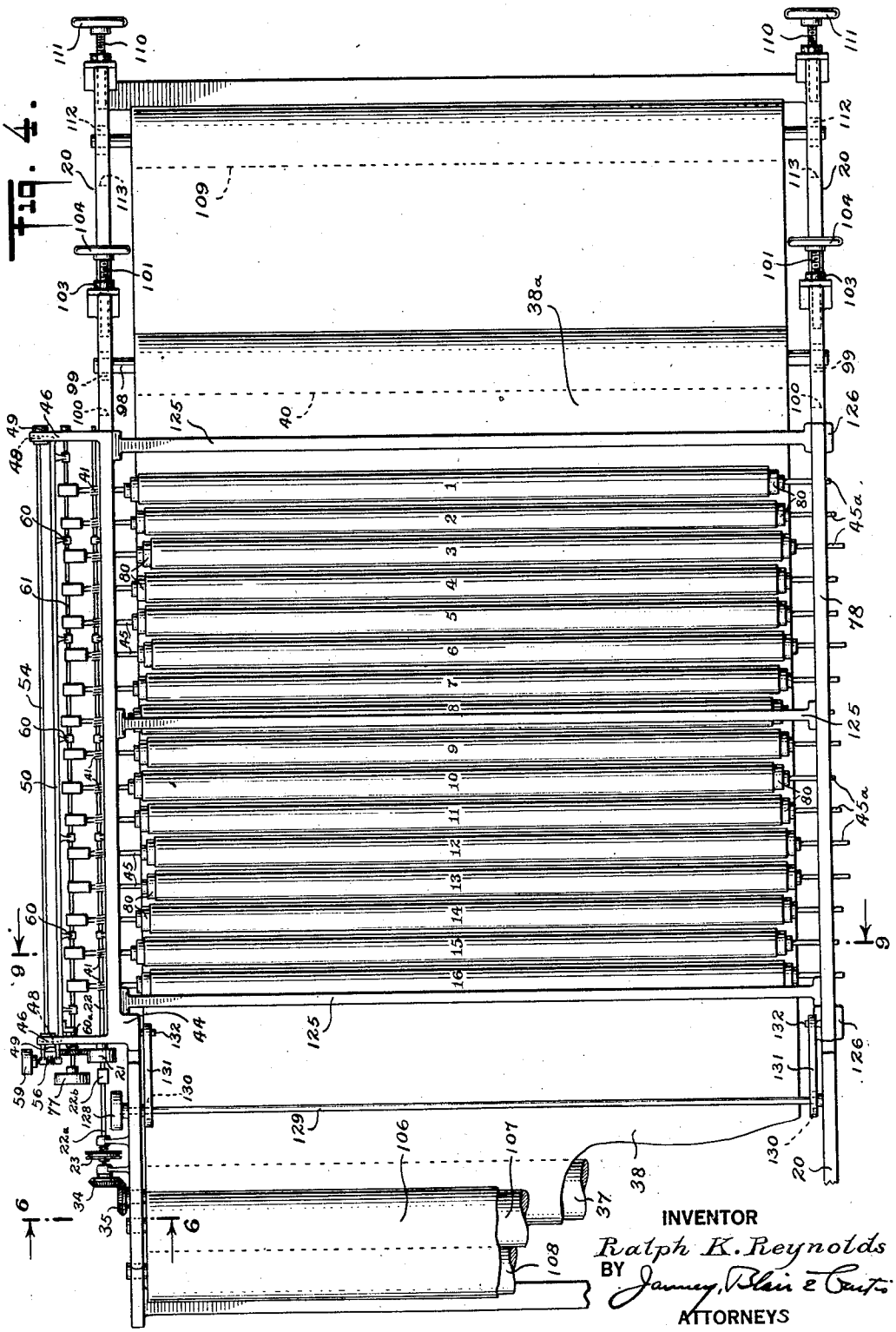
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FELTING MACHINE

Filed Dec. 23, 1931 6 Sheets-Sheet 2

Fig. 4.



Dec. 18, 1934. R. K. REYNOLDS 1,984,700

FELTING MACHINE

Filed Dec. 23, 1931 6 Sheets-Sheet 3

Fig. 5.

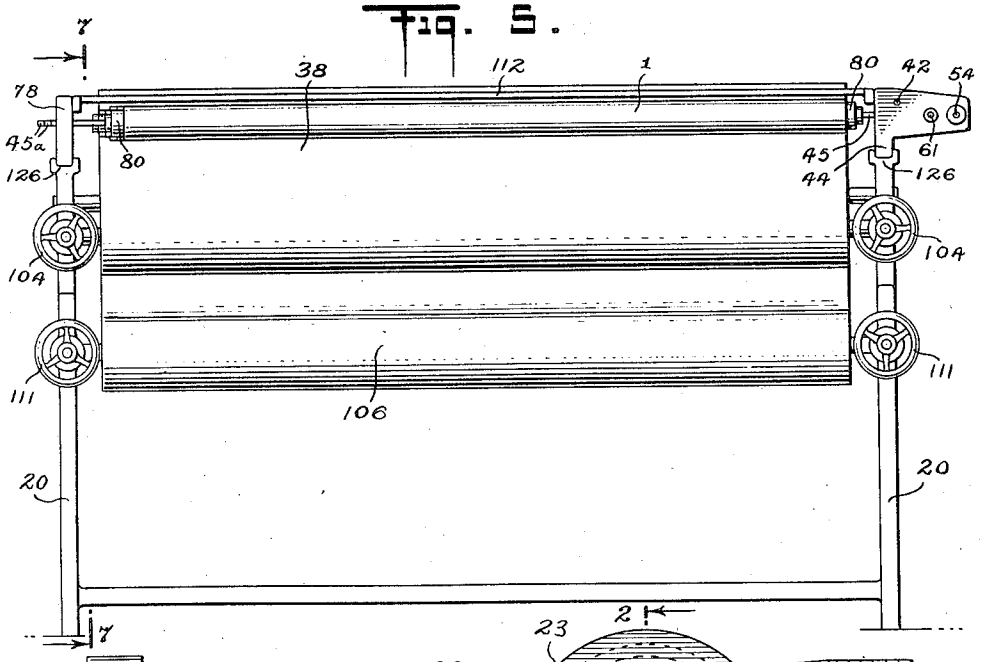
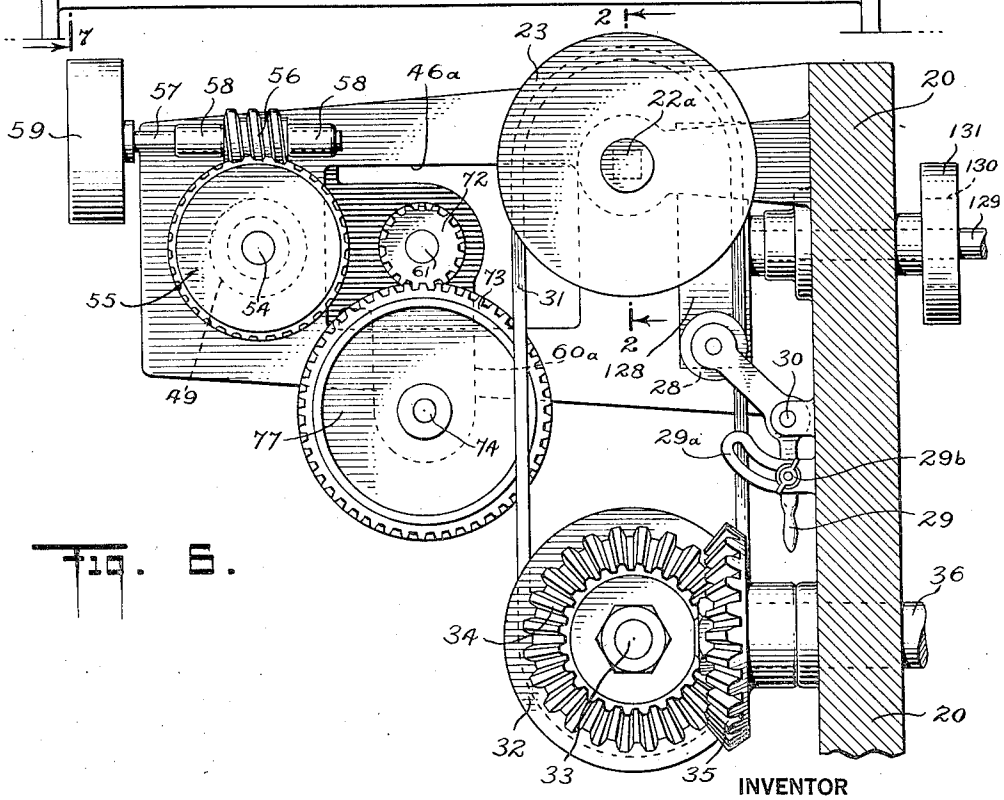


Fig. 6.



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FELTING MACHINE

Filed Dec. 23, 1931 6 Sheets-Sheet 4

Fig. 7.

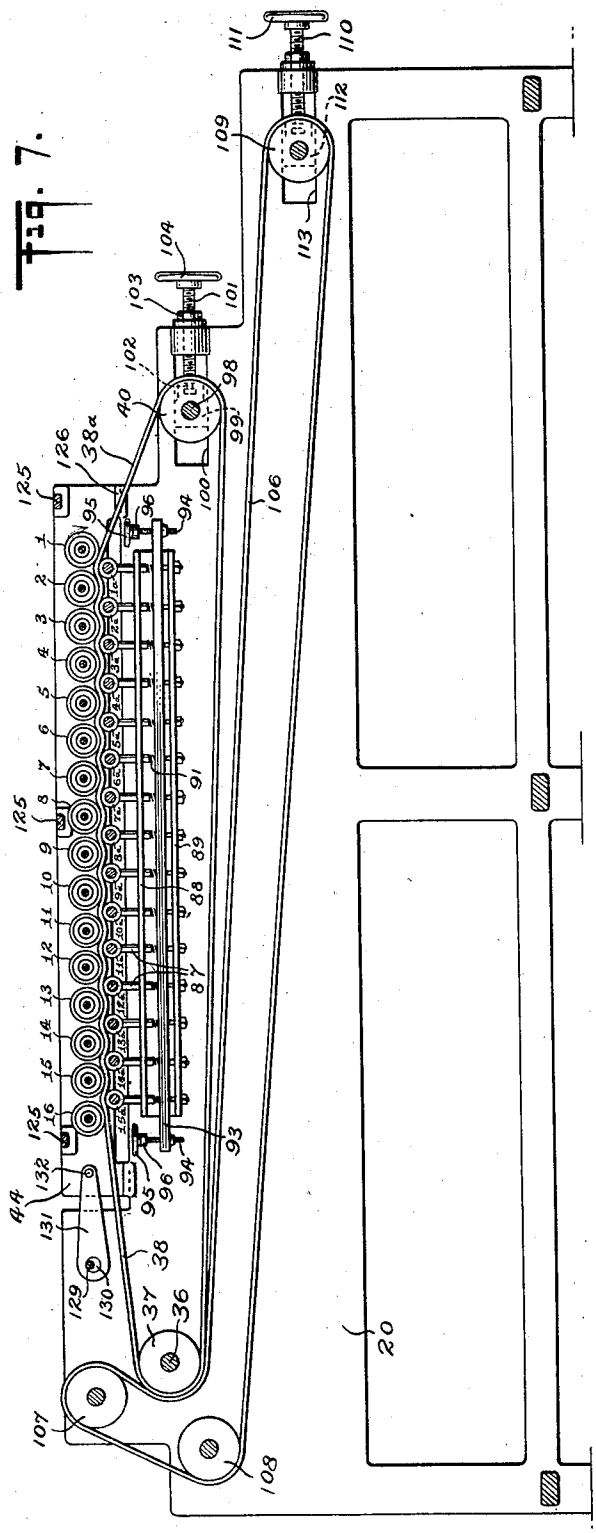
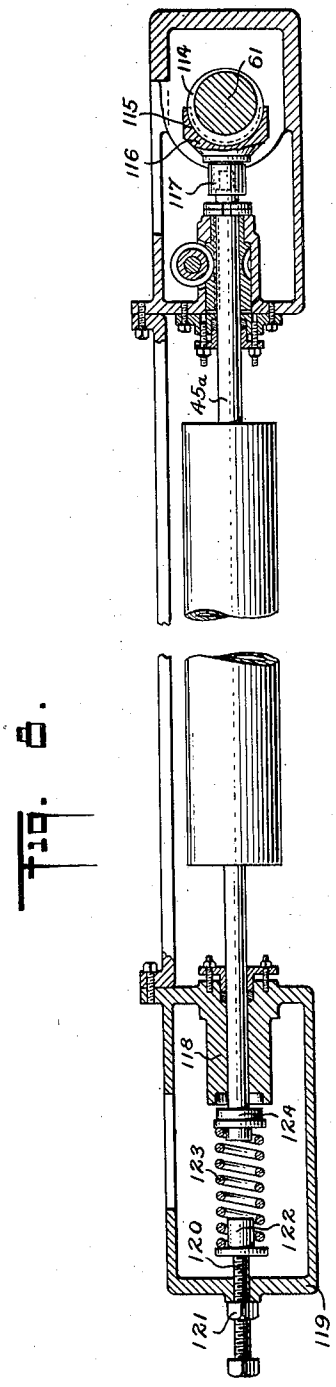


Fig. 8.



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Dec. 18, 1934. R. K. REYNOLDS 1,984,700

FELTING MACHINE

Filed Dec. 23, 1931 6 Sheets-Sheet 5

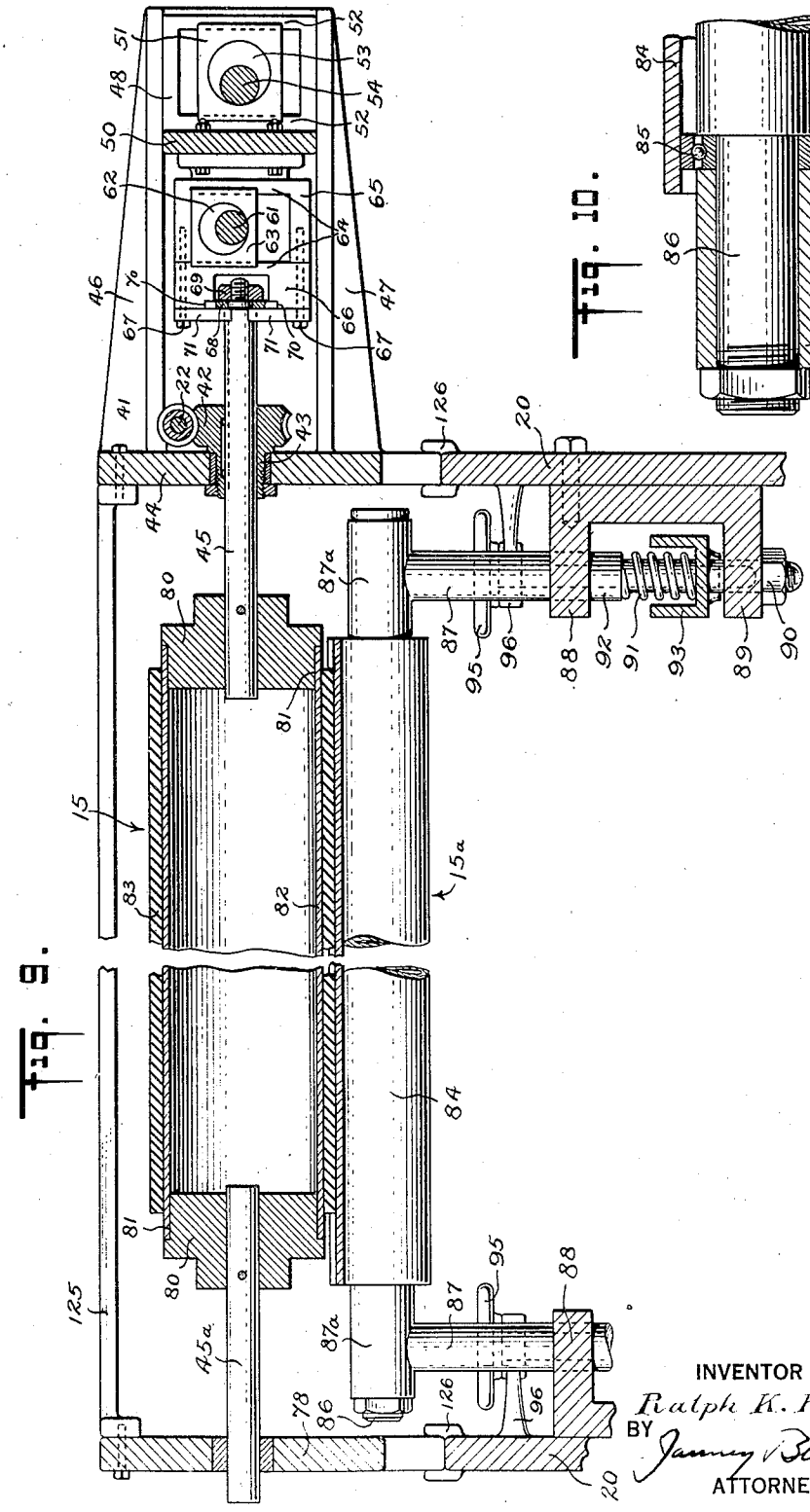


Fig. 9.

Fig. 10.

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Dec. 18, 1934. R. K. REYNOLDS 1,984,700

FELTING MACHINE

Filed Dec. 23, 1931 6 Sheets-Sheet 6

Fig. 11.

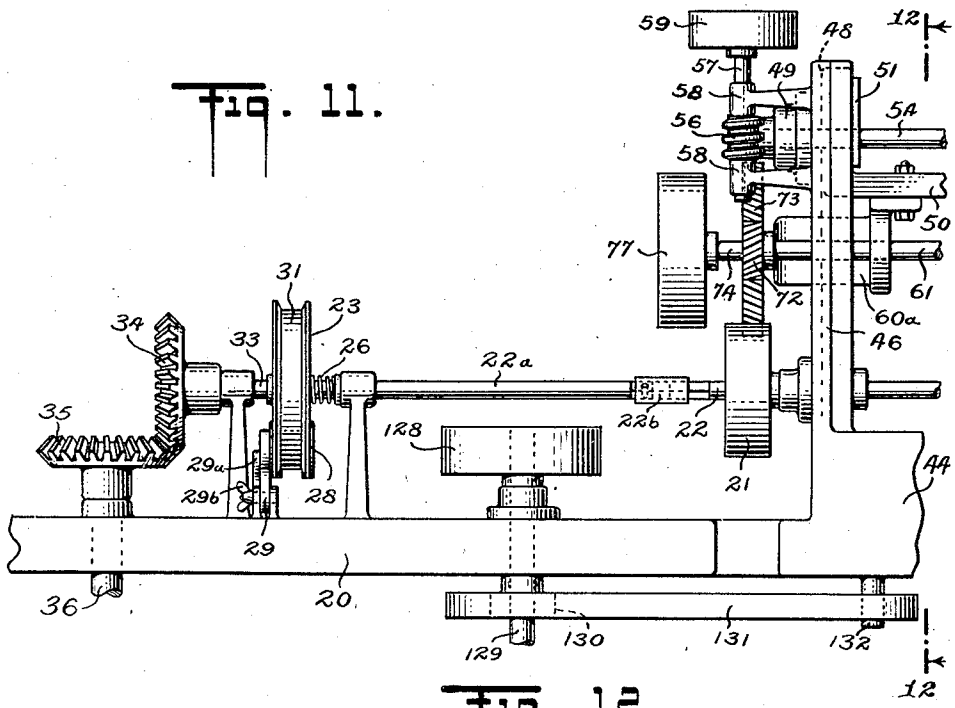
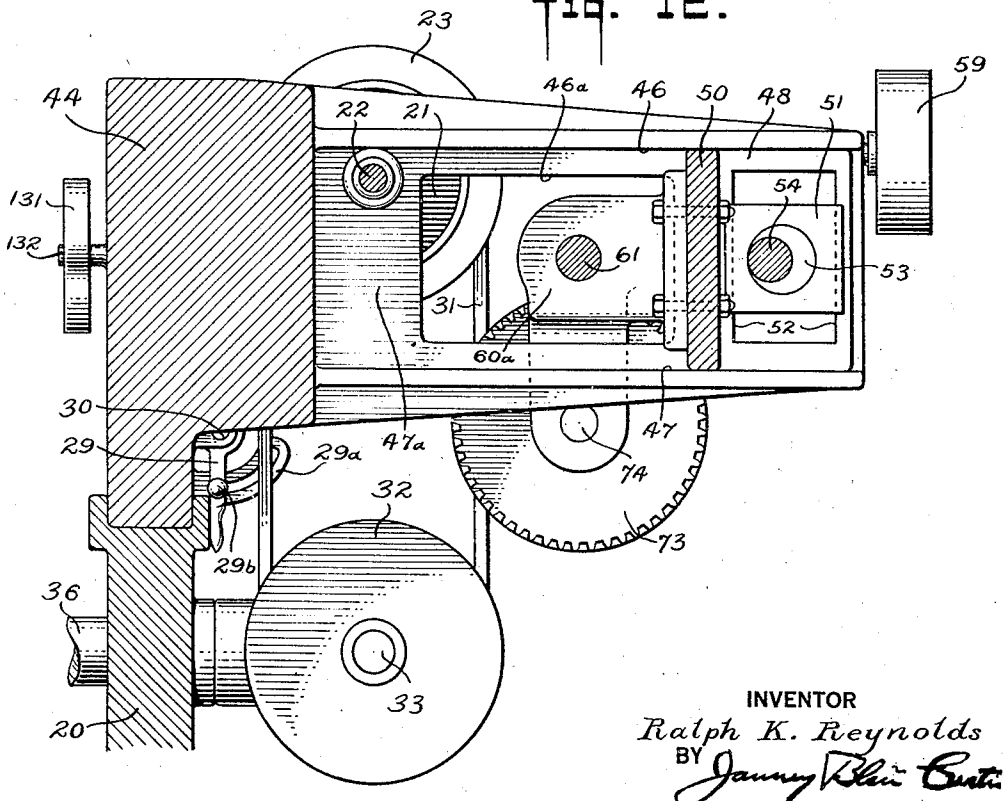


Fig. 12.



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UNITED STATES PATENT OFFICE

1,984,700

FELTING MACHINE

Ralph K. Reynolds, Danbury, Conn.

Application December 23, 1931, Serial No. 582,720

40 Claims. (Cl. 28—5)

The invention relates to apparatus for and a method of shrinking and felting articles made of fur or other fibers possessing felting properties.

One of the objects of the invention is to provide a machine of the character indicated adapted to perform the felting or sizing operation efficiently. Another object of the invention is to provide a machine of the character indicated adapted to perform the entire felting operation. Another object of the invention is to provide a machine adapted for the rapid sizing of objects to be felted. Another object of the invention is to provide a machine and method adapted for the production of an extremely durable felt. Another object of the invention is to provide a machine and method for felting hat bats which shall avoid certain undesirable characteristics of former machines and methods. Another object of the invention is to reduce wear of the hat bats during the felting operation. Another object of the invention is to effect automatic crozing of the hat bats without deformation thereof. Other objects will be in part obvious or in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, arrangements of parts, and in the several steps and relation and order of each of said steps to one or more of the others thereof, all as will be illustratively described herein, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings, in which is shown one of various possible embodiments of the mechanical features of this invention,

Figure 1 is a side elevation of a machine constructed in accordance with the invention;

Figure 2 is a detailed view of a variable speed pulley;

Figure 3 is a diagrammatic view illustrating the phase relationship of the vibrating rollers;

Figure 4 is a plan view of the machine;

Figure 5 is a front elevation of the machine;

Figure 6 is an enlarged elevation of the driving mechanism for the machine;

Figure 7 is a vertical sectional view, taken on the line 7—7 of Figure 5;

Figure 8 is a sectional view showing a modified form of vibrating mechanism;

Figure 9 is an enlarged sectional view, taken on the line 9—9 of Figure 4 and showing the roller operating mechanism in elevation; and

Figure 10 is a fragmentary view, showing the construction of one of the lower rollers.

Figure 11 is a plan view of the driving mechanism upon an enlarged scale; and

Figure 12 is a sectional view taken on the line 12—12 of Figure 11.

Similar reference characters refer to similar parts throughout the several views of the drawings.

As conducive to a clear understanding of this invention, it is observed that the property of felting is a property existing in certain fibers, for example rabbit's fur, whereby when a mass of such fibers are laid together and properly treated, both chemically and mechanically, they interlock to form a fabric, and in so doing foreshorten as a mass, both in length and breadth, and at the same time gain in thickness and density, still considering the fibers as a mass. Mechanical treatment to generate or assist the felting action has consisted either in rolling up the article to be felted, for example a hat bat, and kneading it, or subjecting it in a flat condition to the action of rollers and the like. The effect of prior machines and methods has been to knead the hat bodies, such kneading consisting essentially of bending of the plies thereof. According to some methods, it has been necessary to croze the hat bats between successive operations in order to prevent the formation of a mark in the hat. Hitherto it has been proposed to do this automatically in machines by moving the lower ply slightly faster than the upper ply, or vice versa.

Referring now to Figure 1, the machine herein illustrated, being a typical embodiment of the machine part of the present invention, is mounted on a suitable frame 20. Referring now to Figure 1 in connection with Figures 6, 11 and 12, the machine may be driven from any suitable source of power and, as illustrated, is adapted to be driven from an overhead countershaft, not shown, by means of belts. A pulley 21 so driven is mounted upon a shaft 22 journaled as will be hereinafter described. Mounted upon a shaft 22*a* that is connected to the shaft 22 by a sliding connection 22*b* is a V-type pulley 23 the details of which are illustrated in Figure 2. As shown in that figure, a pair of conical discs 24 and 25 are mounted upon the shaft 22*a* and are urged together by a spring 26. That portion of the shaft 22*a* upon which the discs 24 and 25 are mounted is preferably square, so that they may be positively driven. A V-shaped belt 31 passes over the pulley 23 and the effective diameter of the pulley 23 may be varied by a mechanism which will now be described.

Referring to Figures 6 and 12, the belt 31 passes around an integral V-type pulley 32. An idler roller 28 is mounted upon a lever 29 pivoted at 30 to the machine frame. By means of a fixed seg-

ment 29a and a wing nut 29b, the lever 29 may be fixed in various adjusted positions. Each separate position of the idler 28 causes the belt 31 to assume a different position radially of the pulley 23, thus to determine a different speed ratio between the pulleys 23 and 32.

The pulley 32 is mounted upon a shaft 33 which is journaled in brackets fastened to the machine frame 20. Also mounted upon the shaft 33 is a beveled gear 34 which meshes with and drives a beveled gear 35 secured to a shaft 36. The shaft 36 is journaled in the sides of the machine frame 20, and between the sides of the machine frame has mounted thereon and secured thereto a roller 37, which is best shown in Figure 7.

Referring now to Figure 7, a belt or apron 38 passes around the roller 37 and around an idler roller 40 at the other end of the machine and between a set of upper rollers marked 1 to 16 inclusive, and a set of lower rollers marked 1a to 15a inclusive. These rollers are arranged in staggered relation, as shown in Figure 7, and the rollers 1 to 16 inclusive are preferably of a light construction such as will be hereinafter described, are located fairly close together in order to reduce the possibility of hat bats moving out of their intended path, and are preferably of a diameter of the order of between two and three inches.

Referring again to Figure 4, the shaft 22 has thereon a plurality of worms 41. Each worm 41 meshes with a wormwheel 42 located below it, as specifically illustrated for a single worm and wormwheel in Figure 9. Each wormwheel 42 has preferably formed integral therewith a sleeve 43 which is mounted in a bearing in a sliding frame 44. Keyed to each sleeve 43 is a shaft 45 upon which is constructed, in a manner which will be hereinafter more fully described, one of the upper rollers 1 to 16 inclusive.

By reason of the mechanism described, the upper rollers 1 to 16 inclusive are positively rotated in a clockwise direction, Figure 7. The belt or apron 38 is likewise rotated and in a counterclockwise direction, Figure 7. With the discs 24 and 25 of the V pulley 23 so disposed with respect to each other as to maintain the belt 31 at some position between the extreme limits offered by the adjustability of the pulley 23, the mechanism is designed to give a theoretical peripheral velocity of the rollers 1 to 16 inclusive the same as the linear speed of the belt 38. In machines of this character, there is apt to be a certain amount of slippage in the drive for the apron, and in some cases for the drive of the rollers. By means of the adjustable pulley 23 exact coincidence between the peripheral velocity of the rollers and the belt or apron may achieved, or that amount of difference between the speeds of the rollers and the belt which will cause them to feed hat bats through the machine without creating any longitudinal crozing thereof. This is an important feature of the invention, for, by a merely theoretical equality of movement of the rollers and the belt in prior machines, it has been found that a certain amount of crozing of the hat bats in a longitudinal direction was effected, and this type of crozing creates excessive wear of the hat bats and is apt to leave marks in the finished article, and consequently I desire to avoid it. Furthermore, even if the speed of apron and rollers were perfectly synchronized in a new machine, wear of the rollers would destroy this synchronization. Adjustment of the effective diameter of the pulley 23 may be made while the machine is operating by movement of the lever 29, and thus the desired effect upon the hat bats may be readily achieved.

Referring now to Figures 4, 5, 9, 11 and 12, a plurality of guideways 46 and 47 extend laterally from the sliding frame 44 at one side thereof, the guideways 46 and 47 being aligned, with the former above the latter. Between each pair of guideways 46 and 47 are mounted sliding heads 48 for horizontal movement in said guideways. The heads 48 are all secured to a cross-bar 50 extending substantially the length of the machine and holding the heads 48 together as a unit.

Referring now particularly to Figure 9, mounted for vertical movement in each of the heads 48 is a rectangular block 51 sliding in vertical guideways 52, 52 therein. Each of the blocks 51 encloses an eccentric 53, the several eccentrics being mounted on a shaft 54 and affixed thereto in the same angular position.

Referring now to Figures 4, 6 and 11, the shaft 54 is journaled in bearings 49, 49 secured to the guideways 46, 47, and has affixed to it a wormwheel 55 which is driven by a worm 56 on a shaft 57 mounted in bearings 58, 58 extending from one of the guideways 46. Likewise mounted on the shaft 57 is a pulley 59 which may be driven from a countershaft connected to the countershaft that drives the pulley 21.

As the eccentrics 53 are revolved the blocks 51 are forced to undergo a circular although not an angular movement. The vertical component of this movement results merely in raising and lowering the blocks 51 in the guideways 52, while the horizontal component of this movement reciprocates the heads 48 in the guideways 46 and 47.

Referring now to Figure 4, extending inwardly from the cross-bar 50 are a plurality of integral portions 60 in which are formed journals for the support of a shaft 61. Referring to Figures 11 and 12, at that end of the machine having the driving mechanism, and fastened to the cross-bar 50 is a journal casting 60a in which is a journal for the shaft 61 and a journal for another shaft which will be hereinafter referred to. The casting 60a is of irregular shape, of substantial strength, and extends through an opening 46a in a connection portion 47a connecting the guideways 46 and 47 for the purpose of giving them the required rigidity. Referring now to Figure 9, upon the shaft 61 are mounted a plurality of eccentrics 62 which are received in blocks 63 slidable vertically in guideways 64, 64 formed in the separate portions 65 and 66 of a yoke, the parts 65 and 66 being secured together by bolts 67, 67. As the shaft 61 is revolved by means of a drive which will be hereinafter described, the blocks 63 are moved in a circular path thus imparting a horizontal reciprocation to the yokes 65, 66.

The combined or resultant movement imparted by the reciprocation of the heads 48 and the yokes 65 and 66 by reason of the revolution of the eccentric shafts 54 and 61 is imparted to the respective shafts 45. To the end of each shaft 45 is secured a washer 68 by means of a nut 69. The washers 68 fit in arcuate depressions 70 formed in the parts 66 of the yokes, and are held therein by blocks 71, 71 which also encircle the shafts 45 in order to provide a substantial bearing surface between the shafts and means for reciprocating them. The blocks 71 may be removably secured in position by the bolts 67.

The reciprocation of the cross-bar 50 is a slow reciprocation which slowly moves the locus of the upper rollers 1 to 16 inclusive along their axes. The reciprocation imparted by the cam shaft 61 to the rollers 1 to 16 inclusive is in the nature of a vibration, being preferably of the order of from 800 to 1200 complete reciprocations per minute, and as each shaft 45 is vibrated by a separate eccentric 62, the rollers 1 to 16 may be vibrated in any relative order desired. The two motions are compounded at the yokes 65, 66, so that said yokes partake of both motions and transmit them to the shafts 45.

Referring now to Figures 6, 11 and 12, in order to drive the shafts 61 at the high rate of speed indicated there is provided at one end of this shaft a small gear 72 which meshes with a large gear 73 on a short shaft 74 mounted in a journal in the lower portion of the journal casting 60*a*, hereinbefore described. Mounted on the shaft 74 is a pulley 77 which may be driven from an overhead countershaft. The pulley 77 undergoes a limited horizontal movement but not enough to interfere with an overhead belt drive, and an idler pulley may be provided if desired.

Referring now to Figure 9, which shows in detail the construction of and support for the roller 15, as typical of the construction of and means of support for all the rollers 1 to 16 inclusive, the roller shaft 45*a* is supported by a journal block in a sliding frame 78. As already stated the roller shaft 45 is supported by the sleeve 43 which is received in a journal in the other sliding frame 44. On the shafts 45 and 45*a* and suitably secured to them are roller ends 80, 80 having reduced portions 81. Mounted on the reduced portions 81 and rigidly connecting the roller ends 80, 80 is a metal cylinder 82. The tubular shaft or cylinder 82 has thereon a covering 83 which may be of rubber or other suitable material.

Referring now to Figure 7 in connection with Figures 9 and 10, the lower rollers 1*a* to 15*a* inclusive may be constructed in the same manner as the upper rollers 1 to 16 inclusive or they may be of a different construction desirably slightly smaller in diameter than the upper rollers being preferably between one and one-half and two inches in diameter. Considering now a particular embodiment of the construction and mounting for the lower roller 15*a* as typical of the construction and mounting for each of the lower rollers, a roller shell 84 is mounted in ball bearings 85, 85 the inner races of which are mounted on a shaft 86 which is supported by the enlarged ends 87*a* of rods 87, 87 which extend vertically through bearings in a pair of brackets 88, 89 secured to the frame members 20 and extending inwardly therefrom. Nuts 90 limit the upward movement of the rods 87, 87 while springs 91 on the rods urge them upwardly, the springs extending between washers 92 secured to the rods and a beam 93. Referring now to Figure 7, for the purpose of adjusting the tension on the several rollers 1*a* to 15*a* inclusive, the beam 93 may be raised or lowered, by means of screws 94 having handwheels 95 the screws being held from vertical movement by collars 96 secured to the machine frame 20.

The rollers 1*a* to 15*a* inclusive engage the underface of the belt 38 and exert tension upon it to press hat bats between the belt 38 and the rollers 1 to 16 inclusive. By reason of the fact that the lower rollers 1*a* to 15*a* inclusive are movable vertically, the belt 38 may be depressed at any point in its travel under the rollers 1 to 16 inclusive for the reception of one or more hat bats being operated upon by the machine.

Referring now to Figure 7, for the purpose of removing any slack which may exist in the belt 38, and for the purpose also of setting the roller 40 in parallel relation to the roller 37, the roller ends 98 of the roller 40 are mounted in blocks 99 movable in guideways 100 provided in the machine frame 20. The blocks 99 are movable forwardly and rearwardly of the machine frame by means of screws 101, which have annular recesses 102 received in collars, not shown, attached to the blocks 99. Each screw 101 passes through a tapped portion of the machine frame, and to firmly secure the blocks 99 in adjusted position lock nuts 103 are provided. As shown in Figure 5 as well as in Figure 7, handwheels 104 are provided for the adjustment of the opposite ends of the roller 40, which may thus be moved bodily forwardly or rearwardly of the machine and also adjusted angularly in order to correct any tendency of the belt 38 to creep to one side of the machine.

The machine having been started in operation, the operator places hat bats to be sized upon the portion 38*a* of the belt 38, which as viewed in Figure 7 is moving to the left. The hat bats are moved by the belt 38 successively under the rollers 1 to 16 inclusive, and by reason of the staggered arrangement of the under rollers 1*a* to 15*a* inclusive are bent back and forth. At the same time the fibers of the hat bats are rapidly vibrated by the vibratory action of the upper rollers described, thus materially assisting the felting action as already explained. In addition to the vibratory motion imparted by the upper rollers, the upper ply of each hat bat is gradually moved laterally, first in one direction and then in the other, thus effecting a crozing of the hat bats by shifting the plies around the axis of the bat, and preventing the formation of a permanent crease in the bats. This method of crozing is characterized by lack of harmful deformation of the bats particularly with respect to the tips thereof, which are apt to be deformed by a continuous relative creeping action in a longitudinal direction. Desirably the speed of the belt 38 is between 20 and 30 feet a minute, and the slow reciprocation imparted by the shaft 54 is timed to bring the plies of each hat bat back to their original relative position in one passage through the machine. In other words, the heads 48 move through a complete reciprocation while a hat bat is moving from the roller 1 to the roller 16. This slow crozing reciprocation may have an amplitude of the order of ½ an inch, while the fast vibratory action of the rollers desirably has an amplitude of the order of ⅜ of an inch.

Despite the high speed of reciprocation of the rollers imparted by the shaft 61, undesirable strains are not set up in the machine by reason of the fact that the rapid vibration of the rollers 1 to 16 is in balanced phase relationship. Referring now to Figure 3 in connection with Figure 4, the position of the several eccentrics 62 upon the shaft 61 is diagrammatically indicated by the numbers of the several rollers 1 to 16 inclusive which each eccentric reciprocates in Figure 3, and Figure 4 shows the actual relative position of the rollers at a given instant. It will be noted that the eccentrics 62 are advanced around the shaft 61 in increments of 90°, and furthermore that the relative displacement between nodal points of successive eccentrics is sometimes

clockwise and sometimes counterclockwise. This particular phase relationship is merely illustrative of a balanced phase relationship of the reciprocating means for the rollers which reduces vibration and it is noted that the irregular action upon the hat bats induced by the irregular relative motion between successive rollers assists the felting action by vibrating different parts of the hat bats differently at a given instant. Owing to the fact that each hat bat is always in contact with the belt 38, the vibration of the fibers is accompanied by a kneading action. The felting action may be stimulated by a supply of water or other liquid which may be discharged upon the upper portion of the machine, the frame being open for that purpose.

Referring again to Figure 7, hat bats which have passed through the machine are automatically returned to the front thereof by means of a belt 106. This belt 106 passes around rollers 107, 108 and 109 and may, if desired, derive its motion from the frictional contact of the belt 106 with the belt 38 as the latter passes over the roller 37, all as clearly shown in Figure 7. In order to adjust the tension on the belt 106 and prevent it from creeping to either side, the roller 109 may be adjusted by means of screws 110 turned by handwheels 111 and cooperating mechanism including blocks 112 slidable in guideways 113, this mechanism being, if desired, identical with that described for the adjustment of the roller 40. An operator operating the machine may remove hat bats from the belt 106 and send them through the machine again as many times as desired, and by reason of the provision of the return belt 106 one operator may suffice to attend to the operation of a machine.

Referring now to Figure 8, there is disclosed a modified form of vibrating mechanism for the rollers 1 to 16 inclusive. The shaft 61 has mounted thereon a plurality of cams 114 which may be arranged in the same phase relationship as already described for the eccentrics 62 and may have the same throw. Each cam 114 engages an arcuate tappet face 115 in a tappet 116. Each tappet 116 engages a cap 117 secured to the end of a shaft 45*a*, and consequently the vibratory motion is transferred to the shaft.

Each shaft 45*a*, according to the modification of the invention disclosed in Figure 8, is mounted for rotary and reciprocating movement in a bearing 118 provided in a frame 119 attached to the machine frame 20 or to the sliding frame 78. The frame 119 is tapped for the reception of a plurality of adjustment bolts 120 secured in adjusted position by means of nuts 121, each bolt supporting a spring holder 122 which receives the thrust of a spring 123 the opposite end of which bears against a cap 124 which is rotatably mounted upon the end of a shaft 45*a*.

The shafts 45 and 45*a* being coaxial and attached by means of the several rollers as already described, the thrust of each cam 114 is resisted by a spring 123, and the several rollers 1 to 16 inclusive are thus vibrated at a high rate of speed as in the other modification of the invention. The mechanism associated with the modified mechanism of Figure 8 may be otherwise identical with that already described, or any other equivalent may be substituted.

Referring now to Figures 1, 4, 5, 7 and 9, the sliding frames 44 and 78 are connected by means of a plurality of overhead connections 125 so as to constitute in effect a unit. The frames 44 and 78 rest in guideways 126, 126 on the top of the side frame members 20. The guideways 126, 126 extend around the lower portion of the sliding frame members 44, 78 in order to hold the entire unit from movement transversely with respect to the machine. Nevertheless the entire unit comprising the sliding frames 44, 78 and the connections 125, together with the guideways 46, 47 and the various parts which they support, including driving mechanism to slowly reciprocate the upper rollers 1 to 16 inclusive and the driving mechanism to rapidly reciprocate these rollers is movable longitudinally of the machine frame and may be so moved, as will be presently described.

So far as certain features of the invention are concerned, the longitudinal reciprocation of the upper bank of rollers 1 to 16 inclusive may be dispensed with. Nevertheless, certain advantages are derived from the reciprocation of the entire unit just described, but it is pointed out that preferably this reciprocation has a very slight amplitude, for example of the order of ⅛ of an inch, and preferably is a rapid reciprocation, constituting a vibratory action with a rate of vibration of the order of 300 complete reciprocations per minute. A vibration of this order will not disturb the driving connections of the machine, for example the belts driving the rollers 21, 77 and 59, for the reason that it is too slight in amplitude to affect a belt drive connection. By reason of the provision of the sliding connection 22*b*, relative motion between the shafts 22 and 22*a* is possible to permit this vibration. Pulleys 77 and 21 may be connected to their shafts by a splined connection involving axial play if desired.

Referring now particularly to Figures 4 and 11, the unit described may be vibrated in any suitable manner, for example by means of a pulley 128 which may be driven from an overhead countershaft, which pulley 128 is mounted on the end of a cross shaft 129 extending across the machine frame and journaled in the side frame members 20 thereof. Adjacent these side frame members 20 are eccentrics 130 driving eccentric rods 131 pivotally connected to pins 132 extending inwardly from the respective sliding frame members 44 and 78. With the construction described, the sliding frame members 44 and 78 may be vibrated or not as desired.

The action upon the hat bats of the longitudinal vibratory motion of the upper rollers 1 to 16 inclusive is a kneading action in certain respects and in other respect a vibratory action affecting the individual fibers by means of the inertia thereof. It is pointed out that the longitudinal vibration of the upper rollers acts to compress the fibers of a hat bat at certain portions thereof such as to effect a rubbing action thereof. Substantially no longitudinal crozing effect is created upon the hat bats by reason of this motion on account of the high speed and the small amplitude thereof. The thorough vibration, kneading and folding of a hat bat effected by the machine of the invention induces a rapid felting of the fibers thereof resulting in shrinkage to size of the hat bats.

It will thus be seen that there has been provided by this invention a method and apparatus in which the various objects hereinabove set forth, together with many thoroughly practical advantages, are successfully achieved.

As various possible embodiments might be made of the mechanical features of the above invention, and as the art herein described might be varied in various parts, all without departing from the scope of the invention, it is to be understood that

all matter herein set forth, or shown in the accompanying drawings, is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. In a machine for felting hat bodies, in combination, a plurality of rollers, means for vibrating said rollers along their axes, and means for vibrating said rollers perpendicular to their axes.

2. In a machine for felting hat bodies, the combination with an apron, a plurality of rollers contacting said apron, means to move the apron, and means to rotate the rollers, of a driving connection between the means to move the apron and the means to rotate the rollers, and means to change the speed ratio of said driving connection whereby to synchronize the peripheral velocity of the rollers with the speed of the apron.

3. In a machine for felting hat bodies, the combination with an apron, a plurality of rollers contacting said apron, means to move the apron, and means to rotate the rollers, of a driving connection between the means to move the apron and the means to rotate the rollers, and a control for said driving connection which may be operated while the machine is in motion and which is adapted to adjust said driving connection for small changes of the speed ratio of the apron and the periphery of the rollers.

4. In a machine for felting hat bodies, the combination with a plurality of lower rollers, spring means supporting said lower rollers, an apron supported by said lower rollers, means to move said apron, a set of upper rollers in contact with said apron, means to reciprocate said upper rollers rapidly and individually, means to axially reciprocate all of said rollers slowly in the same direction as the fast axial reciprocation but in unison, and means superimposed upon the other two motions for reciprocating all of said upper rollers in unison in the same plane viz. the plane of all their axes but in a direction substantially perpendicular to the first two mentioned reciprocations.

5. In a machine for felting hat bodies, in combination, a bank of rollers, means adapted to carry a group of hat bats along said rollers and in engagement therewith, means adapted to reciprocate each of said rollers axially independently of the axial movement of the other rollers of said bank, and means adapted to reciprocate said entire bank of rollers as a unit independently of the individual reciprocation of said rollers.

6. In a machine for felting hat bodies, in combination, a bank of rollers, means adapted to carry a group of hat bats along said rollers and in engagement therewith, means adapted to reciprocate each of said rollers axially independently of the axial movement of the other rollers of said bank, means adapted to reciprocate said entire bank of rollers as a unit independently of the individual reciprocation of said rollers, and means for rotating said rollers about their axes.

7. In a machine for felting hat bodies, in combination, a bank of rollers, means adapted to carry a group of hat bats along said rollers and in engagement therewith, means adapted to reciprocate each of said rollers axially independently of the axial movement of the other rollers of said bank, means adapted to reciprocate said entire bank of rollers as a unit independently of the individual reciprocation of said rollers, means for rotating said rollers about their axes, and means adapted to synchronize the peripheral speeds of said rollers with the speed of said first-mentioned means.

8. In a machine for felting hat bodies, in combination, a bank of rollers, means adapted to carry a group of hat bats along said rollers and in engagement therewith, means adapted to reciprocate each of said rollers axially independently of the axial movement of the other rollers of said bank, and means adapted to reciprocate said entire bank of rollers as a unit independently of the individual reciprocation of said rollers, the speed of reciprocation of said rollers as a unit being slower than the speed of reciprocation of each individual roller.

9. In a machine for felting hat bodies, in combination, a bank of rollers, means adapted to carry a group of hat bats along said rollers and in engagement therewith, means adapted to reciprocate each of said rollers axially independently of the axial movement of the other rollers of said bank, and means adapted to reciprocate said entire bank of rollers as a unit independently of the individual reciprocation of said rollers, the individual reciprocation of each roller being out of phase with the remaining rollers so that the momentum of said rollers is always in balance.

10. In a machine for felting hat bodies, in combination, a bank of rollers, means adapted to carry a group of hat bats along said rollers and in engagement therewith, means adapted to reciprocate each of said rollers axially independently of the axial movement of the other rollers of said bank, and means adapted to reciprocate said entire bank of rollers as a unit independently of the individual reciprocation of said rollers, said bank of rollers being divided into groups of rollers, and the individual reciprocation of each of the rollers of each group being out of phase with the remaining rollers of this group so that the momentum of the rollers of each group is always in balance.

11. In a machine for felting hat bodies, in combination, a bank of rollers, means adapted to carry a group of hat bats along said rollers and in engagement therewith, means adapted to reciprocate each of said rollers axially independently of the axial movement of the other rollers of said bank, means adapted to reciprocate said entire bank of rollers as a unit independently of the individual reciprocation of said rollers, said bank of rollers being divided into groups of rollers, and the individual reciprocation of each of the rollers of each group being out of phase with the remaining rollers of this group so that the momentum of the rollers of each group is always in balance, and means for rotating said rollers.

12. In a machine for felting hat bodies, in combination, a bank of rollers, means adapted to carry a group of hat bats along said rollers and in engagement therewith, means adapted to reciprocate each of said rollers axially independently of the axial movement of the other rollers of said bank, means adapted to reciprocate said entire bank of rollers as a unit independently of the individual reciprocation of said rollers, said bank of rollers being divided into groups of rollers, and the individual reciprocation of each of the rollers of each group being out of phase with the remaining rollers of this group so that the momentum of the rollers of each group is always in balance, means for rotating said rollers, and means for synchronizing the peripheral speed of said rollers with the speed of said first-mentioned means.

13. In a machine for felting hat bodies, in combination, a bank of rollers, means adapted to carry a group of hat bats along said rollers and in engagement therewith, means adapted to reciprocate each of said rollers axially independently of the axial movement of the other rollers of said bank, means adapted to reciprocate said entire bank of rollers as a unit independently of the individual reciprocation of said rollers, said bank of rollers being divided into groups of rollers, and the individual reciprocation of each of the rollers of each group being out of phase with the remaining rollers of this group so that the momentum of the rollers of each group is always in balance, means for rotating said rollers, and means forming a connection between said last-mentioned means and said first-mentioned means and adapted to synchronize the peripheral speed of said rollers with the speed of said first-mentioned means.

14. In a machine for felting hat bodies, in combination, a bank of rollers, means adapted to carry a group of hat bats along said rollers and in engagement therewith, means adapted to reciprocate each of said rollers axially independently of the axial movement of the other rollers of said bank, means adapted to reciprocate said entire bank of rollers as a unit independently of the individual reciprocation of said rollers, and means adapted to reciprocate said bank as a unit in a direction substantially perpendicular to the direction of reciprocation imparted to said bank by said last-mentioned means.

15. In a machine for felting hat bodies, in combination, a bank of rollers, means adapted to carry a group of hat bats along said rollers and in engagement therewith, means adapted to reciprocate each of said rollers axially independently of the axial movement of the other rollers of said bank, means adapted to reciprocate said entire bank of rollers as a unit independently of the individual reciprocation of said rollers, and means adapted to reciprocate said bank as a unit in a direction substantially perpendicular to the direction of reciprocation imparted to said bank by said last-mentioned means and in the plane of the axes of said rollers.

16. In a machine for felting hat bodies, in combination, a bank of rollers, means adapted to carry a group of hat bats along said rollers and in engagement therewith, means adapted to reciprocate each of said rollers axially independently of the axial movement of the other rollers of said bank, means adapted to reciprocate said entire bank of rollers as a unit independently of the individual reciprocation of said rollers, means adapted to reciprocate said bank as a unit in a direction substantially perpendicular to the direction of reciprocation imparted to said bank by said last-mentioned means and in the plane of the axes of said rollers, and means for rotating said rollers.

17. In a machine for felting hat bodies, in combination, a bank of rollers, means adapted to carry a group of hat bats along said rollers and in engagement therewith, means adapted to reciprocate each of said rollers axially independently of the axial movement of the other rollers of said bank, means adapted to reciprocate said entire bank of rollers as a unit independently of the individual reciprocation of said rollers, means adapted to reciprocate said bank as a unit in a direction substantially perpendicular to the direction of reciprocation imparted to said bank by said last-mentioned means and in the plane of the axes of said rollers, means for rotating said rollers, and means for synchronizing the peripheral speed of said rollers and said first-mentioned means.

18. In a machine for felting hat bodies, in combination, a bank of rollers, means adapted to carry a group of hat bats along said rollers and in engagement therewith, means adapted to reciprocate each of said rollers axially independently of the axial movement of the other rollers of said bank, means adapted to reciprocate said entire bank of rollers as a unit independently of the individual reciprocation of said rollers, the individual reciprocation of said rollers being out of place to effect at all times a balance of the momentum of said rollers, and means adapted to reciprocate said bank as a unit in a direction substantially perpendicular to the direction of reciprocation imparted to said bank by said third-mentioned means.

19. In a machine for felting hat bodies, in combination, a bank of rollers, means adapted to carry a group of hat bats along said rollers and in engagement therewith, means adapted to reciprocate each of said rollers axially independently of the axial movement of the other rollers of said bank, means adapted to reciprocate said entire bank of rollers as a unit independently of the individual reciprocation of said rollers, the individual reciprocation of said rollers being out of phase to effect at all times a balance of the momentum of said rollers, means adapted to reciprocate said bank as a unit in a direction substantially perpendicular to the direction of reciprocation imparted to said bank by said third-mentioned means, and means for rotating said rollers.

20. In a machine for felting hat bodies, in combination, a frame, a plurality of rollers mounted in said frame, drums mounted for rotation beneath said frame, an endless apron stretched about said drums and capable of carrying hat bats into engagement with said rollers, means for reciprocating said frame in a direction substantially parallel to the plane of said apron, means for reciprocating said frame in a direction substantially perpendicular to the direction of reciprocation imparted by said last-mentioned means, and means adapted to rotate said drums.

21. In a machine for felting hat bodies, in combination, a frame, a plurality of rollers mounted in said frame, drums mounted for rotation beneath said frame, an endless apron stretched about said drums and capable of carrying hat bats into engagement with said rollers, means for reciprocating said frame in a direction substantially parallel to the plane of said apron, means for reciprocating said frame in a direction substantially perpendicular to the direction of reciprocation imparted by said last-mentioned means, means adapted to rotate said drums, and means adapted to rotate said rollers.

22. In a machine for felting hat bodies, in combination, a frame, a plurality of rollers mounted in said frame, drums mounted for rotation beneath said frame, an endless apron stretched about said drums and capable of carrying hat bats into engagement with said rollers, means for reciprocating said frame in a direction substantially parallel to the plane of said apron, means for reciprocating said frame in a direction substantially perpendicular to the direction of reciprocation imparted by said last-mentioned means, means adapted to rotate said drums, means adapted to rotate said rollers, and means

adapted to synchronize the peripheral speed of said rollers with the speed of said apron.

23. In a machine for felting hat bodies, in combination, a frame, a plurality of rollers mounted in said frame, drums mounted for rotation beneath said frame, an endless apron stretched about said drums and capable of carrying hat bats into engagement with said rollers, means for reciprocating said frame in a direction substantially parallel to the plane of said apron, means for reciprocating said frame in a direction substantially perpendicular to the direction of reciprocation imparted by said last-mentioned means, means adapted to rotate said drums, means adapted to rotate said rollers, and means forming a direct connection between said last two mentioned means to synchronize the peripheral speed of said rollers with the speed of said apron.

24. In a machine for felting hat bodies, in combination, a frame, a plurality of rollers mounted in said frame, drums mounted for rotation beneath said frame, an endless apron stretched about said drums and capable of carrying hat bats into engagement with said rollers, means for reciprocating said frame in a direction substantially parallel to the plane of said apron, means for reciprocating said frame in a direction substantially perpendicular to the direction of reciprocation imparted by said last-mentioned means, means adapted to rotate said drums, and means adapted to reciprocate each of said rollers independently of the reciprocation of said frame.

25. In a machine for felting hat bodies, in combination, a frame, a plurality of rollers mounted in said frame, drums mounted for rotation beneath said frame, an endless apron stretched about said drums and capable of carrying hat bats into engagement with said rollers, means for reciprocating said frame in a direction substantially parallel to the plane of said apron, means for reciprocating said frame in a direction substantially perpendicular to the direction of reciprocation imparted by said last-mentioned means, means adapted to rotate said drums, and means adapted to reciprocate each of said rollers independently of the reciprocation of said frame, the reciprocation imparted to said rollers by said last-mentioned means being out of phase to effect a balance of momentum of said rollers.

26. In a machine for felting hat bodies, in combination, a bank of rollers, means adapted to carry a group of hat bats along said rollers and in engagement therewith, means for vibrating said rollers along their axes, and means for vibrating said rollers perpendicularly to their axes.

27. In a machine for felting hat bodies, in combination, a bank of rollers, means adapted to carry a group of hat bats along said rollers and in engagement therewith, means for vibrating said rollers along their axes and means for vibrating said rollers perpendicularly to their axes but in substantially the same plane as said axes.

28. In a machine for felting hat bodies, in combination, a bank of rollers, means adapted to carry a group of hat bats along said rollers and in engagement therewith, means for vibrating said bank along the axes of said rollers, and means for vibrating said rollers perpendicularly to their axes but in substantially the same plane as said axes, the amplitude of vibration of said first-mentioned means being greater than the aplitude of vibration of said last-mentioned means.

29. In a machine for felting hat bodies, in combination, a bank of rollers, means adapted to carry a group of hat bats along said rollers and in engagement therewith, means for vibrating said bank along the axes of said rollers, and means for vibrating said rollers perpendicularly to their axes but in substantially the same plane as said axes at a greater speed than the rate of vibration of said first-mentioned means.

30. In a machine for felting hat bodies, in combination, a bank of rollers, means adapted to carry a group of hat bats along said rollers and in engagement therewith, means for vibrating said bank along the axes of said rollers, and means for vibrating said rollers perpendicularly to their axes but in substantially the same plane as said axes, the rate of vibration of said first-mentioned means being such that one complete reciprocation takes place while a single bat passes throughout the length of the rollers.

31. In a machine for felting hat bodies, in combination, a bank of rollers, means adapted to carry a group of hat bats along said rollers and in engagement therewith, means adapted to import individual reciprocation to said rollers in axial directions, and means adapted to vibrate said rollers in a direction perpendicular to their axes at less speed than the rate of reciprocation of said first-mentioned means.

32. In a machine for felting hat bodies, in combination, a bank of rollers, means adapted to carry a group of hat bats along said rollers and in engagement therewith, means adapted to impart individual reciprocation to said rollers in axial directions, and means adapted to vibrate said rollers in a direction perpendicular to their axes, the rate of reciprocation of said first-mentioned means being on the order of 800 to 1200 reciprocations per minute and the rate of reciprocation of said last-mentioned means being on the order of 300 reciprocations per minute.

33. In a machine for felting hat bodies, in combination, a bank of rollers, means adapted to carry a group of hat bats along said rollers and in engagement therewith, means adapted to impart individual reciprocation to said rollers in axial directions, and means adapted to vibrate said rollers in a direction perpendicular to their axes, the amplitude of reciprocation of said first-mentioned means being greater than the amplitude of reciprocation of said second-mentioned means.

34. In a machine for felting hat bodies, in combination, a bank of rollers, means adapted to carry a group of hat bats along said rollers and in engagement therewith, means adapted to impart individual reciprocation to said rollers in axial directions, and means adapted to vibrate said rollers in a direction perpendicular to their axes, the amplitude of reciprocation of said first-mentioned means being substantially three times as great as the amplitude of reciprocation of said second-mentioned means.

35. In a machine for felting hat bodies, in combination, a bank of rollers, means adapted to carry a group of hat bats along said rollers and in engagement therewith, means adapted to impart individual reciprocation to said rollers in axial directions, and means adapted to vibrate said rollers in a direction perpendicular to their axes at considerably less speed than the rate of reciprocation of said first-mentioned means, the amplitude of reciprocation of said first-mentioned means being substantially three times as great as the amplitude of reciprocation of said second-mentioned means.

36. In a machine for felting hat bodies, in combination, a bank of rollers, means adapted to carry a group of hat bats along said rollers and

in engagement therewith, means adapted to reciprocate each of said rollers axially independently of the axial movement of the other rollers of said bank, and means adapted to reciprocate said entire bank of rollers as a unit independently of the individual reciprocation of said rollers, the speed of reciprocation of said last-mentioned means being such that one complete reciprocation of said bank takes place while a bat is passing throughout the length of said rollers.

37. In a machine for felting hat bodies, in combination, a bank of rollers, means adapted to carry a group of hat bats along said rollers and in engagement therewith, means adapted to reciprocate each of said rollers axially independently of the axial movement of the other rollers of said bank, and means adapted to reciprocate said entire bank of rollers as a unit independently of the individual reciprocation of said rollers, the speed of reciprocation of said last-mentioned means being such that one complete reciprocation of said bank takes place while a bat is passing throughout the length of said rollers, and the speed of individual reciprocation imparted by said second-mentioned means being much more rapid.

38. In a machine for felting hat bodies, in combination, a bank of rollers, means adapted to carry a group of hat bats along said rollers and in engagement therewith, means adapted to reciprocate each of said rollers axially independently of the axial movement of the other rollers of said bank, and means adapted to reciprocate said entire bank of rollers as a unit independently of the individual reciprocation of said rollers, the speed of reciprocation of said last-mentioned means being such that one complete reciprocation of said bank takes places while a bat is passing throughout the length of said rollers, and the speed of individual reciprocation imparted by said second-mentioned means being in the neighborhood of 800 to 1200 reciprocations per minute.

39. In a machine for felting hat bodies, in combination, a bank of rollers, means adapted to carry a group of hat bats along said rollers and in engagement therewith, means adapted to reciprocate each of said rollers axially independently of the axial movement of the other rollers of said bank, and means adapted to reciprocate said entire bank of rollers as a unit independently of the individual reciprocation of said rollers, said second-mentioned means adapted to reciprocate said rollers individually at a rate of 800 to 1200 reciprocations per minute.

40. In a machine for felting hat bodies, in combination, a bank of rollers, means adapted to carry a group of hat bats along said rollers and in engagement therewith, means adapted to reciprocate each of said rollers axially independently of the axial movement of the other rollers of said bank, and means adapted to reciprocate said entire bank of rollers as a unit independently of the individual reciprocation of said rollers, the amplitude of the reciprocation of said bank being greater than the amplitude of the reciprocation of said individual rollers.

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