Jan. 13, 1970 F. W. HUDSON ET AL 3,489,463

BRUSH SIZING APPARATUS

Filed Aug. 4, 1967 6 Sheets-Sheet 1

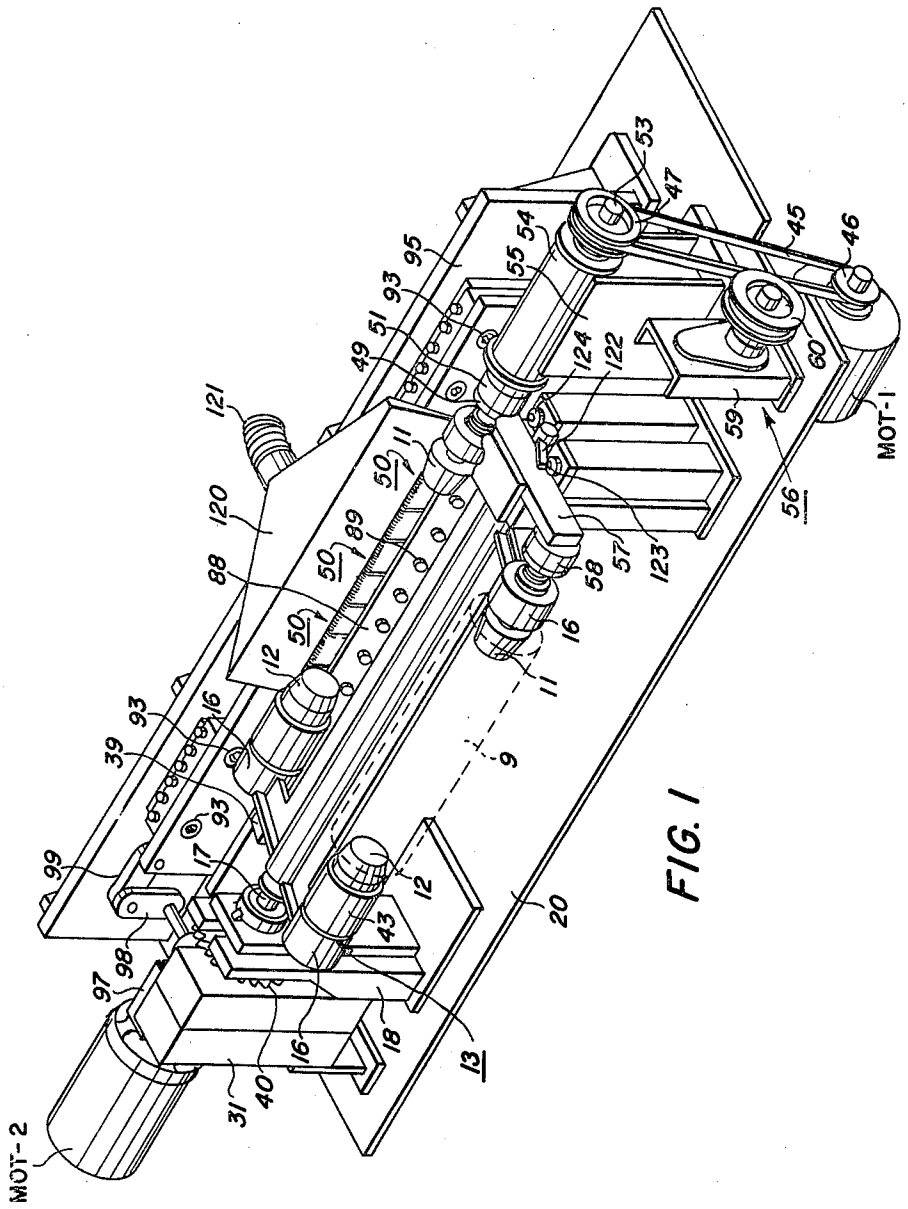


FIG. 1

INVENTORS
FREDERICK W. HUDSON
PAUL J. KAVENY
BY
ATTORNEY

Jan. 13, 1970 F. W. HUDSON ET AL 3,489,463

BRUSH SIZING APPARATUS

Filed Aug. 4, 1967 6 Sheets-Sheet 2

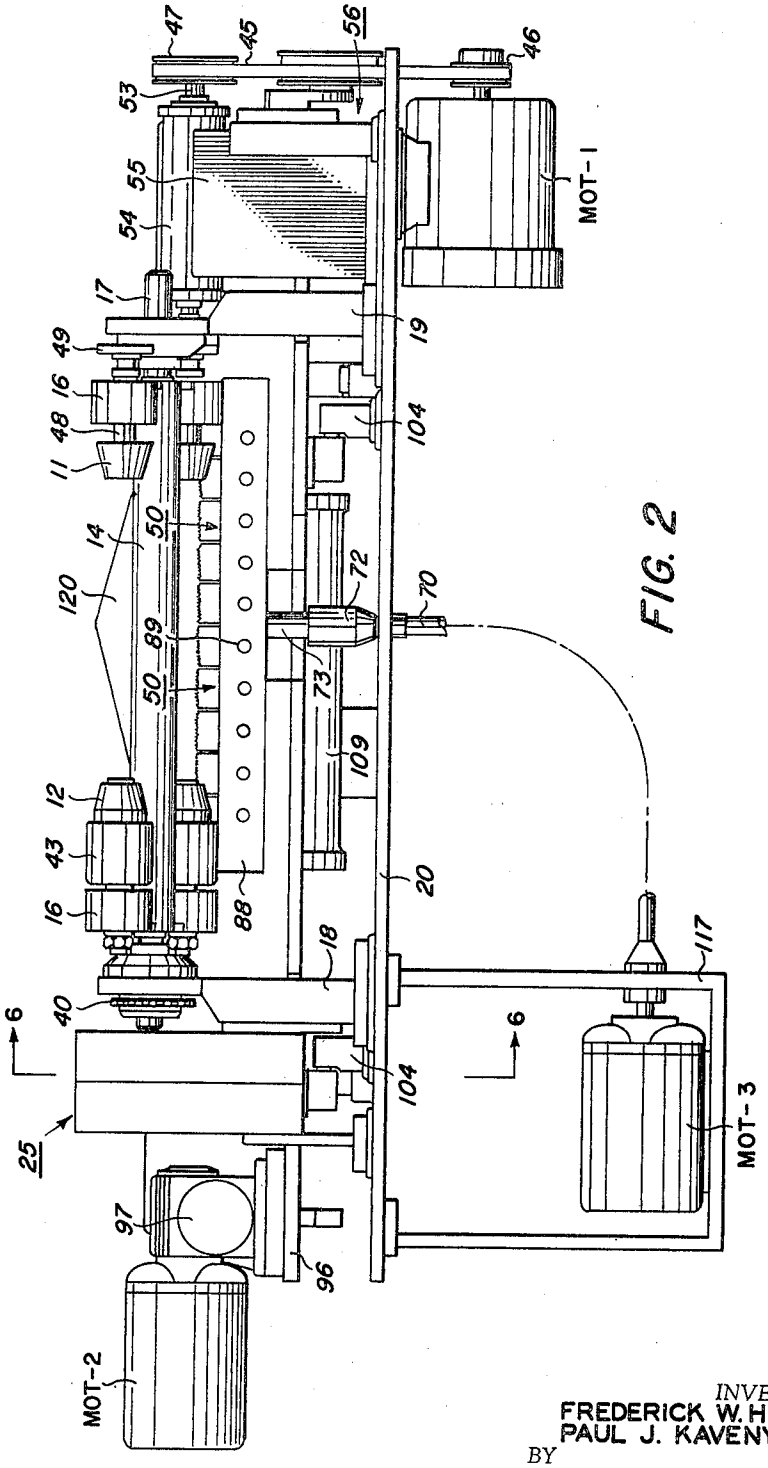


FIG. 2

INVENTORS
FREDERICK W. HUDSON
PAUL J. KAVENY
BY
ATTORNEY

Jan. 13, 1970 F. W. HUDSON ET AL 3,489,463

BRUSH SIZING APPARATUS

Filed Aug. 4, 1967 6 Sheets-Sheet 3

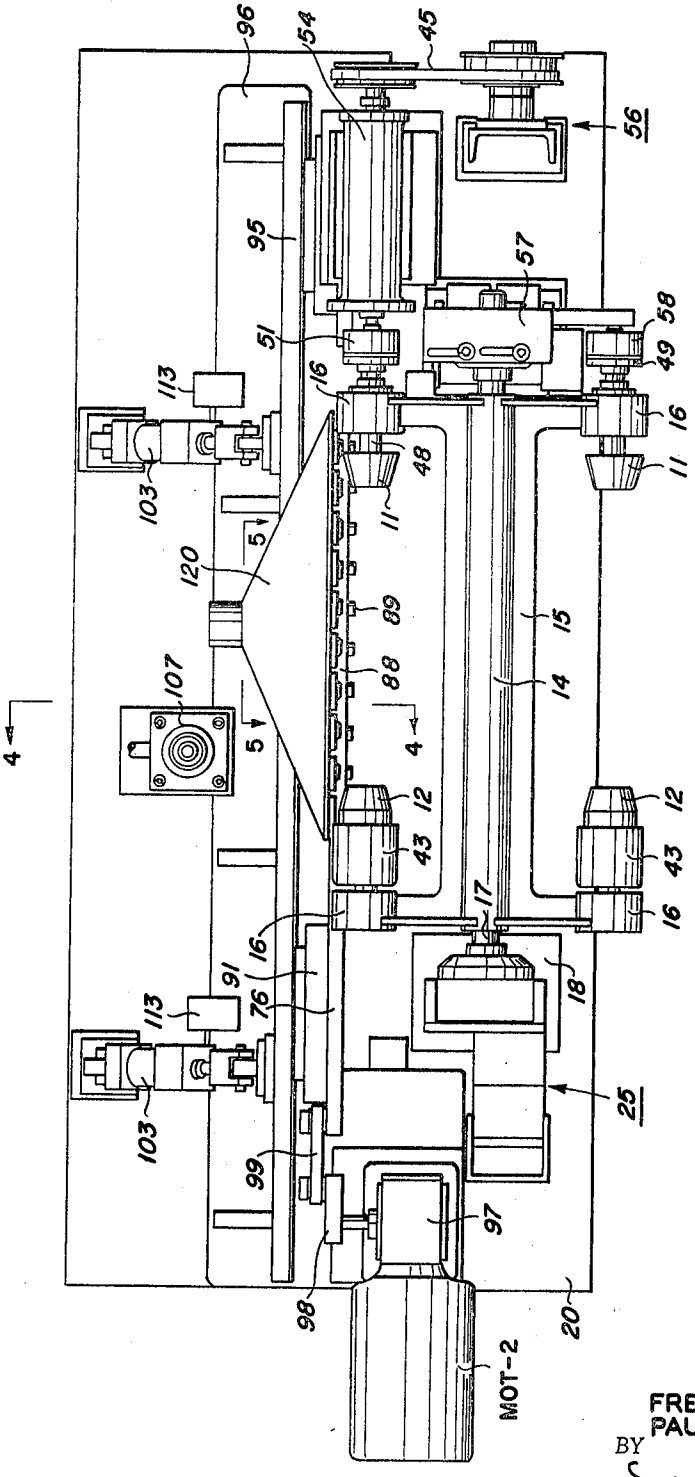


FIG. 3

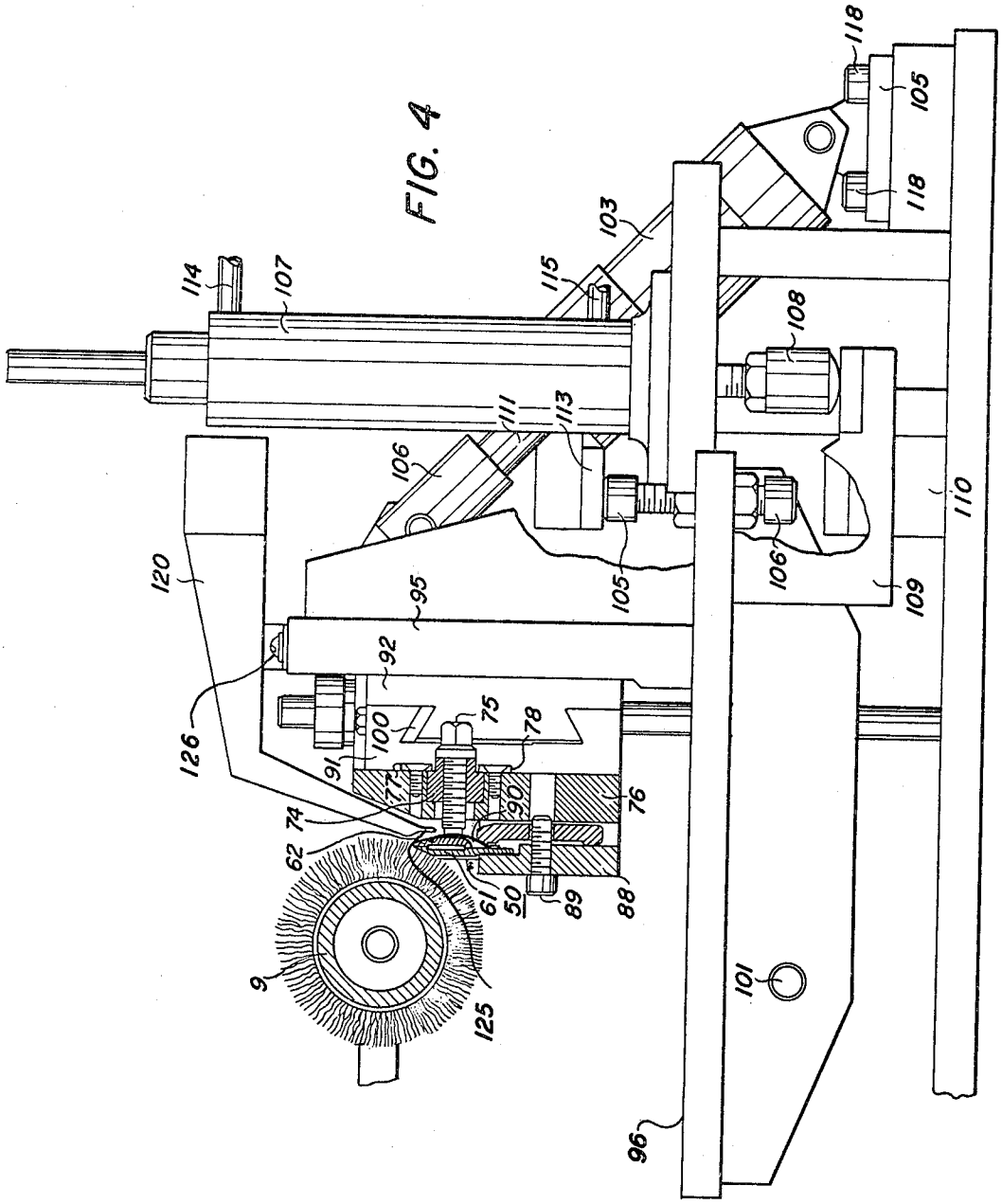
INVENTORS
FREDERICK W. HUDSON
PAUL J. KAVENY
BY
ATTORNEY

Jan. 13, 1970 F. W. HUDSON ET AL 3,489,463

BRUSH SIZING APPARATUS

Filed Aug. 4, 1967 6 Sheets-Sheet 4

FIG. 4



INVENTORS
FREDERICK W. HUDSON
PAUL J. KAVENY

BY

ATTORNEY

Jan. 13, 1970 F. W. HUDSON ET AL 3,489,463

BRUSH SIZING APPARATUS

Filed Aug. 4, 1967 6 Sheets-Sheet 5

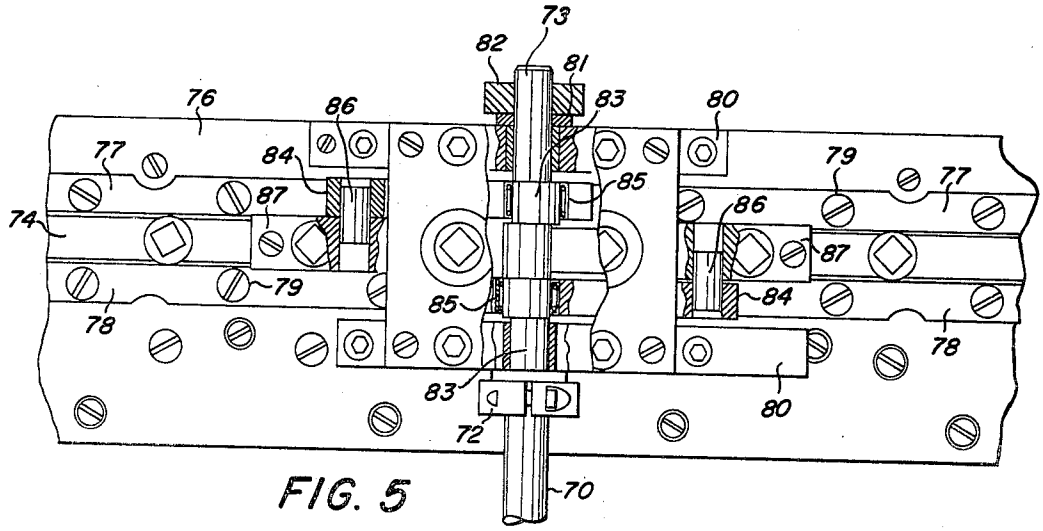


FIG. 5

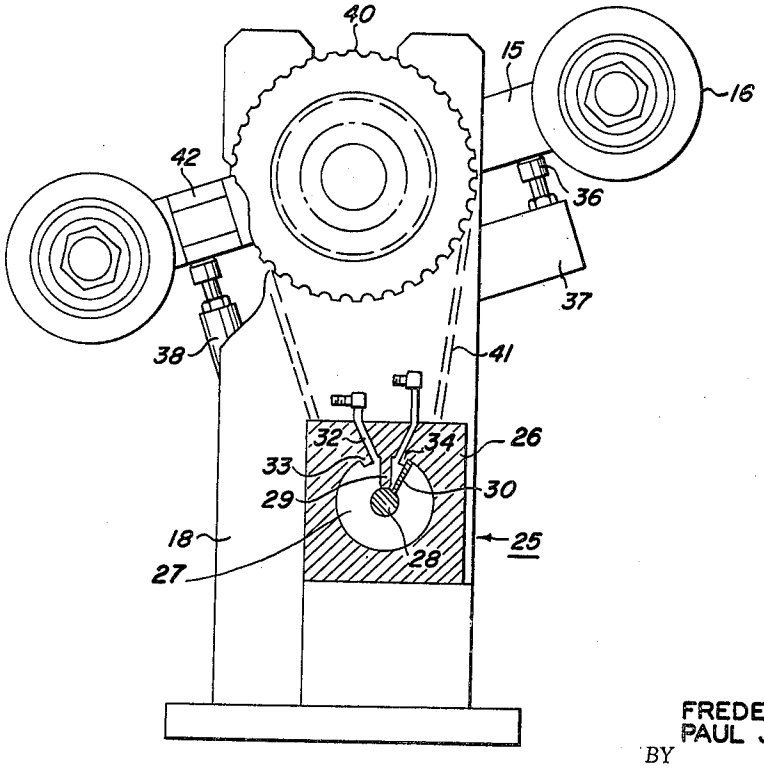


FIG. 6

INVENTORS
FREDERICK W. HUDSON
PAUL J. KAVENY

BY

Norman C. Schneider
ATTORNEY

Jan. 13, 1970 F. W. HUDSON ET AL 3,489,463

BRUSH SIZING APPARATUS

Filed Aug. 4, 1967 6 Sheets-Sheet 6

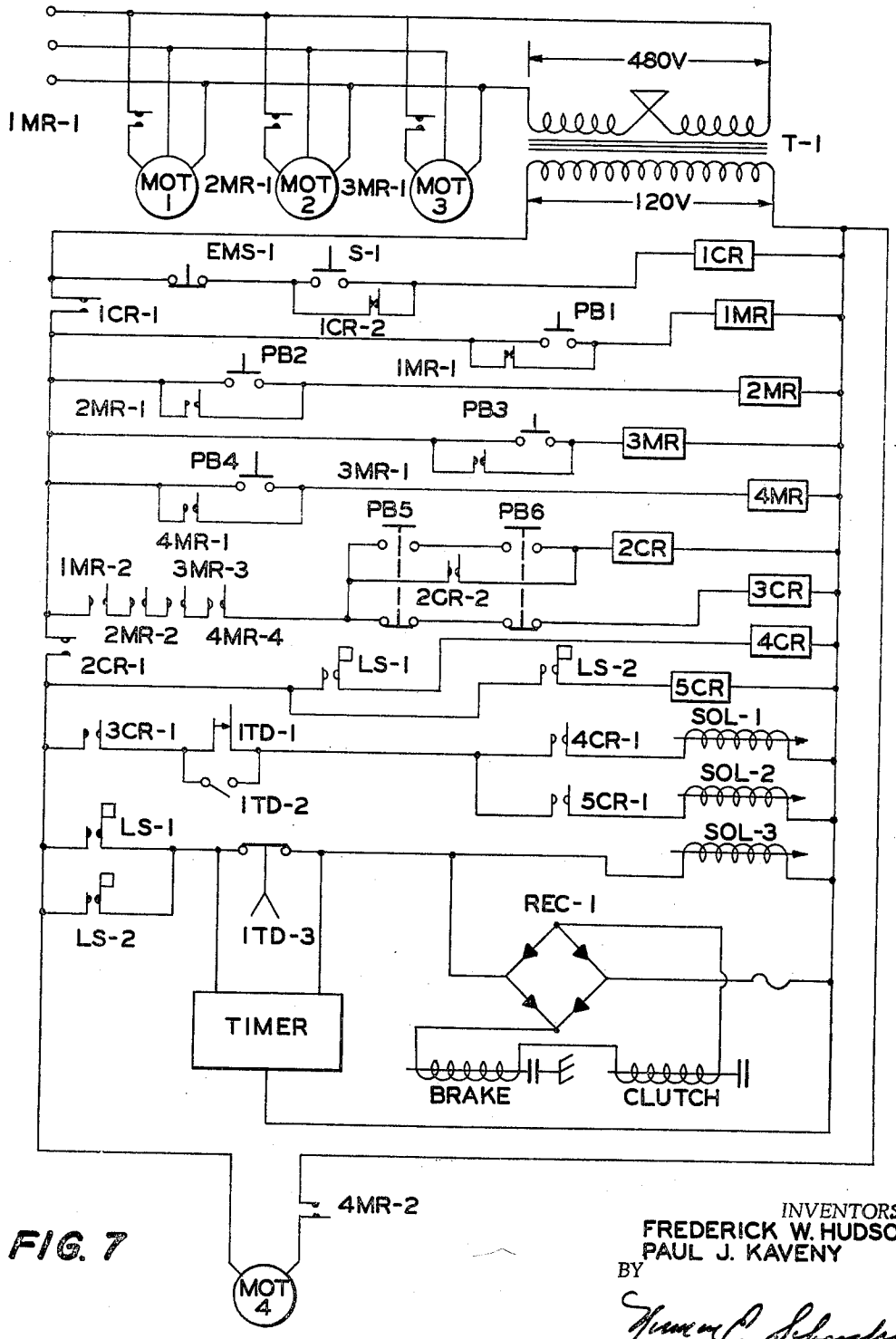


FIG. 7

INVENTORS
FREDERICK W. HUDSON
PAUL J. KAVENY
BY
ATTORNEY

United States Patent Office 3,489,463
Patented Jan. 13, 1970

3,489,463

BRUSH SIZING APPARATUS

Frederick W. Hudson, West Henrietta, and Paul J. Kaveny, Rochester, N.Y., assignors to Xerox Corporation, Rochester, N.Y., a corporation of New York

Filed Aug. 4, 1967, Ser. No. 658,459
Int. Cl. A46d 9/00
U.S. Cl. 300—17 5 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus for sizing the individual hair fibers of a cylindrical cleaning brush to produce a brush having a smooth, even, outer periphery.

This invention relates to apparatus for sizing a cylindrical brush and, in particular, to apparatus for accurately sizing the hair fibers of a cylindrical brush to produce a brush having a symmetrical outer periphery.

More specifically, this invention relates to apparatus for reproducing an even, smooth peripheral surface on a xerographic cleaning brush. In the process of xerography, a plate, comprising a conductive backing upon which is placed a photoconductive insulating material, is charged uniformly and the photoconductive surface then exposed to a light image. The photoconductive coating becomes conductive under the influence of the light image so as to selectively dissipate the electrostatic charge found thereon/or therein to prdouce a latent image. The latent image is then developed by means of a variety of pigmented resins which have been specifically developed for this purpose. The pigmented resins, or as herein referred to "toners," are electrostatically attracted to the latent image found on the photoconductive surface in proportion to the amount of charge found thereon/or therein so that areas of small charge concentration become areas of low toner density while areas of greater charge concentration become proportionaly more dense. The developed latent image can then be transferred to a support material and permanently affixed thereto.

Transfer of a developed latent image is usually effected by a corona generating device which imparts an electrical charge sufficient to attract toner particles from the photoconductive surface to a support material, the magnitude of the charge required to effect transfer being dependent upon many variables. It has been found, however, that some residual developing material will remain behind after transfer is effected. That is, although the electrostatic transfer forces applied to the support material will effect transfer of a preponderance of the developed image, some toner particles possessing the higher magnitude of forces than the transfer forces will remain on the photoconductive surface. A common method of removing this residual toner from a xerographic plate is to treat the plate with a cleaning brush after the transfer operation is completed; the brush fibers being moved rapidly over the plate surface to produce the desired cleaning. For further information concerning suitable apparatus for cleaning a photoconductive surface, reference is had to Turner and Mayo, U.S. Patent No. 2,751,616.

In the xerographic process, a cylindrically shaped, core-mounted, brush is commonly used to clean residual toner from a photoconductive surface because of the obvious advantage afforded by this type of brush. The brush is mounted at a predetermined distance from the plate surface so that the hair fibers are in tangential contiguous contact with the plate surface. Rotating the brush at a relatively high speed causes the hair fibers to flick residual toner from the plate, the flicking action generating a mechanical and triboelectrical force to produce the required

cleaning. It has been found that a cylindrical brush must be accurately sized in order to produce the required force needed to remove residual toner. Each individual hair fiber acts as a relatively thin structural member in that the hair fiber, having a relatively uniform cross-sectional area, behaves in a predetermined manner depending upon the fiber length and material. Long hair fibers will be relatively pliable or flexible and the shorter hair fibers becoming stiffer as the slenderness ratio (the ratio of length to cross-sectional area) decreases. A xerographic cleaning brush having excessively long hair fibers will not produce the desired cleaning action because the hair fibers are slapped or dragged across the photoconductor surface. Rather than producing the required flicking action, the long hair fibers produce what is known as "a soft ride." On the other hand, hair fibers which are too short are too rigid and can produce forces capable of damaging the photoconductive surface. It has been found that a brush having short rigid hair fibers will cause plate abrasions when rotated at relatively high speeds.

It should be clear from the prior discussion that proper sizing of a xerographic cleaning brush is a very important and highly desirous end result in the xerographic art. That is, for each brush material and fiber denier, there is a critical fiber length which must be maintained to produce a brush capable of performing the cleaning operation. Oftentimes the tolerances allowed over the outside diameter of such a brush are extremely small, many times smaller than those encountered in similar art such as the paint roller art or the like.

Although many suitable devices exist for shearing paint rollers and the like, such devices have been found to be incapable of holding the close tolerances required of a xerographic cleaning brush. For example, a common brush shear known in the art employs a series of helical blades mounted on a drum or the like which act in cooperation with a stationary blade to shear hair fibers placed therebetween. The hair fibers are held more or less stationary while the movable blade is rotated at high speed thereby producing a lawn mower effect. As can be seen, to accomplish rapid and complete sizing of each individual hair fiber in this type of apparatus would be extremely difficult because the hair fibers are presented to the cutter in a random hit or miss fashion. Increasing the speed of the offset rotary blade in an effort to accomplish more complete shearing creates vibrations of a magnitude such that accurate sizing of the brush hair fibers cannot be accomplished.

It is therefore an object of this invention to improve apparatus for shearing a cylindrical brush.

It is a further object of this invention to provide apparatus for uniformly sizing the hair fibers of a xerographic cleaning brush.

Another object of this invention is to treat the hair fibers of a cylindrical core-mounted pile fabric to produce a brush having a substantially symmetrical outer periphery.

A still further object of this invention is to provide shearing apparatus for producing a xerographic cleaning brush capable of removing residual toner from a photoconductive surface without abrading said photoconductive surface.

Yet another object of this invention is to rapidly and efficiently shear substantially all the individual hair fibers of a xerographic cleaning brush to a uniform length.

Another object of this invention is to minimize the vibration found in a shearing apparatus so that a cylindrical brush may be accurately sized.

These and other objects of the present invention are attained by rapidly rotating a cylindrical brush so as to uniformly arrange the hair fibers along the brush radials.

A plurality of cutting heads, which are capable of treating the hair fibers of the rotating brush, are mounted in a plane perpendicular to the radially arranged hair fibers. The cutters are advanced into the work a predetermined distance thereby uniformily sizing the hair fibers. The cutting heads are also moved in a lateral direction thereby producing a smooth, even peripheral surface.

For a better understanding of the present invention as well as other objects and further features thereof, reference is had to the following detailed description of the invention to be read in connection with the accompanying drawings, wherein:

FIG. 1 is a left-hand perspective view of the shearing apparatus of the present invention with the surrounding frame and cover plates removed;

FIG. 2 is a front view of the apparatus with the covers and frame broken away to show the internal structure of the machine;

FIG. 3 is a top view of the present invention as shown in FIG. 2;

FIG. 4 is a sectional view through the cutting heads taken along line **4**—**4** in FIG. 3;

FIG. 5 is a view in partial section of the cutting head drive mechanism taken along line **5**—**5** in FIG. 3;

FIG. 6 is a sectional view through the hydraulic drive unit taken along lines **6**—**6** in FIG. 2; and

FIG. 7 is a schematic electrical wiring diagram of the apparatus of the present invention.

The apparatus of the presnt invention is particularly adapted for shearing cylindrical xerographic cleaning brushes having synthetic pile fibers, however it should be clear such apparatus is equally adaptable for shearing cleaning brushes fabricated of natural furs. As disclosed in the previously cited Turner patent, a cylindrical cleaning brush is mounted in an automatic xerographic machine between truncated members in close proximity to the photoconductive surface to be cleaned. The brush is mounted so that some interference exists between the photoconductive surface and the outer extremities of the brush hair fibers. Rapid rotation of the brush causes the hair fibers to be flicked against the photoconductive surface thereby removing residual toner thereon. As can be seen, it is extremely important that the brush fibers are sized to a uniform length so that the desired flicking action is produced and, furthermore, that the outer peripheral surface of the brush be symmetrical about the axial center line so that proper interference is maintained as the brush rotates through 360°.

Referring now to FIGS. 1 through 6, the apparatus of the present invention will be explained in further detail. A brush to be sheared is supported in the present apparatus in the same manner that it would be supported in an automatic xerographic machine. That is, a cylindrical brush **9** (shown in dotted lines), comprising a hollow core upon which a pile fabric is placed, is supported between truncated cone-shaped members **11** and **12** (FIG. 1). By mounting the brush in this manner, it is made to automatically align itself along the identical geometrical center line that it will assume in an automatic xerographic machine. It can be seen that this center line will lie along an imaginary axis passing through the center of truncated members **11** and **12**. This imaginary axis is used in the present invention as a reference point from which the length of the hair fibers can be determined.

Brush **9**, shown positioned in the loading and unloading station of the present apparatus, is supported in a loading frame **13** comprising a cylindrical hub **14** upon which is rigidly affixed two U-shaped members **15**. Bearing hubs **16**, located at the outer extremities of the U-shaped members, are journaled therein to rotatably support truncated members **11** and **12**. Running coaxial with, and extending through, hub **14** is a shaft **17** which is journaled at each end in support members **18** and **19**, respectively. The support members are affixed to the base plate **20** by welding or similar means to provide a permanent base about which the loading frame can be rotated.

The loading frame **13** is free to rotate about shaft **17** so that untreated brush **9** being supported in the loading and unloading station, is advanced into a position where it can be treated by cutting heads **50** herein referred to as the "work zone." The "work zone" is the horizontal area in which the comb-like teeth of cutting heads **50** are capable of contacting and guiding the brush hair fibers into shearing relation with said cutters. It should be noted that this work zone can vary as the size of the brushes vary and means are provided, as described below, to accommodate these brushes in the present invention.

A hydraulic drive unit **25** (FIG. 6) supplies the driving force needed to advance the loading frame (FIG. 6) from the loading and unloading station into the work zone. As shown in FIG. 6, drive unit **25** comprises a housing **26** in which a cavity **27** is formed. Drive shaft **28** is centered in the cavity and fits snugly against the embossed section **29** extending from the main housing. Vane **30** is permanently affixed to the shaft and runs the entire length of the cavity opening to divide the cavity into two separate chambers. Rotation of the loading frame is produced by introducing hydraulic fluid under pressure from reservoir **31** (FIG. 1) through intake-exhaust port **32** to exert a force against vane **30** sufficient to drive shaft **28** in a direction from stop **33** towards stops **34**. Hydraulic drive shaft **35** extends exterior the housing and has affixed thereto a drive sprocket (not shown). The drive sprocket transmits rotational motion to the loading frame by means of sprocket **40** acting through chain **41**. The position of the loading frame in the work zone, and therefore the location of a brush supported therein, is established by means of stops **36** which are positioned to engage embossed sections **39** located at either end of one of the U-shaped members **15**. By providing only one U-shaped member with embossed sections, the frame is restricted in its movement to swing through only 180° of arc. As can be seen, the direction of rotation of the loading frame is reversed for each loading and unloading cycle. That is, a brush advanced into the work zone is returned to an unloading position by reversing the direction of rotation of loading frame **13**. As shown in FIG. 6, blocks **37** and **38** are welded, or permanently affixed in a similar manner, to support members **18**. The blocks are located on the support members in a position so that stops **36** are capable of engaging the embossed sections of the loading frame as the frame swings from one position to another. Hardened steel pads **42** are positioned on the embossed sections and are machined so as to contact the stops in a relativey flat position.

Truncated cone-shaped member **12** is biased outwardly from hub **16** by means of a spring (not shown) located in housing **43**. To load a brush in the shearing apparatus of the present invention, the operator moves truncated cone-shaped member **12** back towards hub **16** to enable the core brush member to be slipped over stationary truncated member **11**. The spring bias member is then allowed to move into contact with the brush until it is seated against the core as shown in FIG. 1. With the brush so positioned, the hydraulic drive unit is actuated by the operator causing the loading frame to swing towards the work zone. The frame will continue to swing until pad **42** encounters stops **36**. It should be noted that although the advancement of the loading frame into the work zone is interrupted, the hydraulic drive unit continues to deliver rotational force to the loading frame thereby positively seating the frame against stops **36**. By applying a continual force to the frame in contact with the stops assures positive seating of the frame in the work zone. Furthermore, this positive seating eliminates unwanted vibrations which would otherwise be found in this type of support.

A brush being supported in the work zone is rotated

at a relatively high speed in order to force the individual hair fibers in a substantially uniform position. That is, the individual hair fibers will be forced outwardly along the radials of the brush thereby enabling them to be individually treated by cutting heads **50**. A motor MOT–**1** located below base plate **20** acts through drive pulley **46** and flexible belt **45** to supply the necessary force to rotate a brush in the work zone. Truncated member **11** is affixed to a shaft **48** which is journaled in hub **16**. Shaft **48** is extended through the hub and terminates in a clutch plate **49** capable of cooperating with either the electromagnetic clutch **51** in the work zone or the electromagnetic brake **58** in the load and unload station. Belt **45** drives driven pulley **47** which is keyed to shaft **53** which passes through bearing housing **54** and is mated to the electromagnetic clutch. As can be seen, rotational force is transmitted to a brush in the work zone when the clutch electrically engages clutch plate **49**. Shaft **53** is journaled in housing **54** and the housing permanently affixed to base plate **20** by means of support member **55**. Also permanently affixed to base plate **20** adjacent to drive belt **45** is an adjustable belt tensioning unit **56** capable of maintaining the desired frictional driving contact in the belt. Tensioning unit **56** comprises a base **59** upon which tensioning pulley **60** is adjustably mounted. Pulley **60** is positioned in contact with the belt so that sufficient tension is introduced in the driving system to insure a positive friction drive to be maintained throughout.

Positioned adjacent to clutch plate **49** in the loading and unloading station is an electromagnetic brake **58** which is mounted on support member **19** by means of arm **57**. It has been found that a brush which is rapidly rotated in the work zone will continue to rotate at relatively high speeds when returned to the unloading station. It is therefore advantageous to provide means to brake or stop this freely rotating brush so that the operator may now readily and rapidly unload a brush returned to this station. The brake also serves a second function in that it will hold truncated member **11** in a non-rotating posture thereby facilitating the loading of a brush into frame **13**. The electric control for both the electromagnetic brake and clutch will be explained in the operations' section below.

Referring now to FIG. 4, brush **9** is shown positioned in the work zone with the hair fibers in tangential contiguous relation with cutting head **50**. As shown in FIG. 1, a plurality of cutting heads are mounted adjacent to each other in a substantially horizontal plane to describe a work zone, the plane described by the cutting heads being parallel to the axial center line of the truncated cone-shaped members. Each shaving head comprises a stationary blade **61** and a movable blade **62** capable of cooperating to shear hair fibers positioned therebetween. Stationary blade **61** has a plurality of comb-like teeth machined therein capable of receiving and directing hair fibers of a rapidly spinning brush into a position where they can be acted upon by movable blade **62**. Movable blade **62**, which is complementary to the stationary blade, is oscillated rapidly in a horizontal direction at a speed sufficient to shear hair fibers moving therebetween. It should be noted that the force acting on the individual hair fibers by the cooperating blade is in a horizontal direction so as not to disturb the centrifugal forces supporting or holding the individual hair fibers in a radial direction.

As previosuly noted, a xerographic cleaning brush must be sized so that its outer periphery is uniform. It has been found that an extremely smooth outer surface can be obtained by placing the cutting blades slightly below the pre-established geometrical axial center line of the brush when the brush is supported in a horizontal plane. The centrifugal forces acting upon the hair fibers, due to the rotation of the brush, causes the hair fibers to bend slightly depending upon material and fiber length. Locating the cutting heads somewhat below the horizontal center line of the brush compensates for this bending action so that the resultant shearing forces will be substantially perpendicular to the hair fibers. The amount of offset, of course, is dependent upon the degree to which each individual fiber bends.

To further aid in the positioning of the hair fibers during the shearing operation, a vacuum hood is placed behind the cutting heads which is capable of creating sufficient negative pressure to pull the hair fibers radially as they pass through the work zone. As shown in FIG. 4, the hood **120** extends the entire length of the work zone and has suction parts **125** therein positioned directly behind the movable cutting blade. A vacuum pump (not shown) is provided which acts through flexible connector **121** to produce the required negative pressure. A further function of this vacuum system is to remove clipped hair fibers from the work zone thereby preventing a build up of residual hair fibers which could hamper the shearing operations. The hood is affixed to support column **95** by means of bolts **126** and does not reciprocate with the cutting heads.

Oscillation of the movable blades is produced by a unitized system driven by flexible shaft **70**. The flexible shaft is directly connected to motor MOT–**3** located beneath stationary base plate **20** in machine frame **117** (FIG. 2). The flexible shaft is connected to cam shaft **73** (FIG. 5) by means of collar **72**. In the present apparatus, a like, or even number, of cutting heads are located on either side of cam shaft **73** and these opposed blades oscillated so that they are moving 180° out of phase creating equal offsetting forces thereby eliminating unwanted machine vibrations. The movable heads on either side of the cam shaft are bolted to a single slide **74** by means of bolts **75** and the slides positioned in a guide member **76**. The slides are held in the guide by upper and lower retaining plates **77** and **78** so that the slide can only move in a horizontal direction. The retaining plates are permanently affixed to the guide member by means of screws **79**. The cam shaft is journaled for rotation in bearing plates **80** which are permanently affixed to guide member **76**, the cam shaft being held in place and properly positioned by means of thrust washer **81** and shaft collar **82**. Two eccentric cams **83** are machined on the cam shaft so that the rise and fall of each is 180° out of phase. An arm **84** is connected to the eccentric portion of the cam shaft by means of needle bearing **85** and the arm operatively connected to the slide **74** through drive member **87**. Arm **84** is free to pivot about drive member **87** by means of pivot pin **86**. It can be seen that rotation of the cam shaft causes the movable blades positioned on either side thereof to be driven horizontally but in opposition to each other.

The stationary blades of the shaving heads are positioned in the slot provided in mounting member **88** and are held in place by means of mounting bolts **89**. The mounting member is then permanently affixed to guide member **76** so that the stationary heads are held in a permanent relation in respect to one another. As can be seen in FIG. 4, the movable blade **62**, which is supported on bolt **75**, is held in close communication with stationary blades **61** by means of spring member **90**. Spring member **90** rides in a groove (not shown) machined in the back of movable member **62** so that the movable blades will be free to oscillate horizontally in respect to the stationary blade. Sufficient clearance is provided between spring member **90** and bolt **75** to enable the movable blades to be driven by slide member **74** through the full rise of eccentric cams **83** (FIG. 5).

Affixed to either end of guide **76** by means of bolts **93** is a female dovetailed member **91** (FIG. 4). A male dovetailed member **92** is moted to the female member **91** and rigidly supported by main support column **95** and the support column, in turn, welded to a movable table **96**. Also permanently affixed to the movable base plate is motor MOT–**2** and its associated gear box **97** which acts through

crank **98** and arm **99** to move buide member **76**, with the cutting heads **50** attached thereto, in a horizontal direction. A shim **100** is positioned between male and female dovetailed members to provide a replaceable bearing surface upon which they cooperate. It can be seen that a two-part motion is imparted to the cutting heads. First, the movable blades are rapidly moved in a horizontal direction to shear individual hair fibers and, second, the cutting heads are reciprocated back and forth so as to produce a smooth, even peripheral surface on a brush being treated. The throw of arm **99** is such that each shaving head will be moved laterally thereby superimposing the work areas of each adjacent cutting head thereby eliminating any blind spots that may be present as well as eliminating transition zones between cutting heads where the shearing might be uneven.

The movable table which supports the cutting heads and their associated driving apparatus, is pivotally mounted upon the stationary base plate **20** so that the cutters can be moved into a brush being supported in the work zone. The movable base plate is mounted on stationary base plate **20** by means of hinges **104** and is free to rotate about hinge pin **101** (FIG. 4). Two hydraulic drive cylinders **103** are pinned to mounting bases **105** and the bases, in turn, being permanently affixed to stationary base plate **20** by means of screws **118**. The piston rod of the hydraulic drive cylinder **103** is in communication with the movable base plate through means of clevis **106**. The degree of rotation of the movable base plate is governed by adjustable stops **105** and **106**, respectively, similar to those employed in the associated loading frame. In operation, a spring loaded pneumatic cylinder **107** is employed to bias the movable base plate in a non-shearing position. That is, cylinder **107** is spring loaded so that the cutters will be moved out of contact with a workpiece when no hydraulic pressure is being delivered to the hydraulic drive cylinders. The spring biased piston acting through contact head **108** exerts a force on arm **109** producing sufficient torque to rotate the movable head about hinges **104**. The plate will continue to swing back, or away from the work, until adjustable stops **106** contact retaining blocks **110** mounted on the stationary base plate. With hydraulic pressure being applied to drive cylinders **103**, piston arm **111** extends thereby advancing the movable base plate toward the work. The table, and therefore cutting heads, continue to advance until stop **105** encouters positioning block **113** affixed to stationary base plate **20**.

A pneumatic cylinder **107** (FIG. 4) provides a biasing force against which drive cylinders **103** acts in moving the cutting heads into the work. Pneumatic cylinder **107** insures that the table will advance smoothly into the work by dampening out, or isolating, any erratic movements in the hydraulic system. An adjustable valve (not shown) is placed betwen pneumatic lines **114** and **115**. The flow of fluid (air) from one side of the pneumatic piston to the other is regulated by setting the adjustable valve and thus the biasing pressure of the system can be regulated. The pneumatic cylinder is spring loaded to return the table to a position where the cutting heads are out of contact with the work when hydraulic pressure is removed from cylinders **103**. Referring to FIG. 4 piston rod, acting through bearing head **108**, forces lever arm **109**, which is affixed to the table, in a downward direction. The table will continue to move downwardly until stop **106** encounters block **110** positioned on the stationary base plate **20**.

The positioning of the cutting heads in reference to a brush supported in the work zone is determined by the placement of adjustable stop **105**. The cylindrical brush is positioned in frame **13** with its axial center line in a predetermined horizontal position and the cutting heads are located in a plane parallel to the axial center line of the brush. Table **96** is rotated about hinge pins **101** so that the cutting heads move into the work uniformly. That is, the plane in which the cutting heads are positioned remains parallel to the axial center line of the brush as the cutting heads are moved into the work. As can be seen, the length to which the hair fibers are sheared, that is, the dimension from the axial center line of the brush to the outer extremity of the radial supported hair fibers, is controlled by the distance the cutting heads are allowed to advance into the work by stop **105**.

MACHINE OPERATION

So that a better understanding of the automatic operations of the present invention may be had, these operations will be described herein with reference to the electronic diagrams shown in FIG. 4. Four hundred and eighty volts are first supplied to the circuit thereby energizing the primary side of transformer T–1. Switch S–1 is then closed thereby providing a circuit for current to flow through the secondary side of transformer T–1 which is wound to step down the voltage to 120 volts. Closing switch S–1 also allows relay 1CR to be energized causing contacts 1CR–1 and 1CR–2 to be closed. Contact 1CR–2 completes a holding circuit around switch S–1 thereby holding relay 1CR energized until such time as the master switch EMS–1 is opened to break the circuit. Closing contact 1CR–1 allows power to reach the motor components of the present apparatus.

With contact 1CR–1 held closed by relay 1CR, the operator is free to manually start the motor components in any desired sequence. Referring once again to FIG. 4, manually depressing palm button PB–1 causes current to reach and energize relay 1MR. With relay 1MR energized, contact 1MR–1 is made completing a holding circuit around spring loaded palm button PB–1 thus allowing the operator to release the button. Energizing 1MR also closes contact 1MR–2 in the 480-volt circuit thereby permitting three-phase power to reach the brush drive motor MOT–1.

Similarly, depressing palm buttons PB–2 and PB–3 energizes relays 2MR and 3MR, respectively, completing holding circuits around the palm buttons through contacts 2MR–1 and 3MR–1. With the above-mentioned relays energized, contacts 2MR–2 and 3MR–2, respectively, are also pulled closed thereby starting motors MOT–2 and MOT–3; motor MOT–2 providing the energy to cause the slide **74** to reciprocate in a lateral direction; and motor MOT–3, acting through flexible shaft **70**, to oscillate the movable blades **62** found in the cutting heads **50**.

As previously noted, a vacuum system is provided to remove sheared hair fibers from the work zone. In order to ready the vacuum system for operation, palm button PB–4 must first be depressed to cause energization of relay 4MR. With 4MR energized, a holding circuit around palm button PB–4 is completed by closing contact 4MR–1. It should also be noted at this time that the four contacts 1MR–3, 2MR–3, 3MR–3, and 4MR–3 in the loading head indexing circuit are also closed by their respective relays. However, before the vacuum motor MOT–4 can be started, the loading head must first be advanced to an indexing position as explained below.

The operator now loads a brush into the loading frame at the load and unload station and is ready to advance the head into the work zone. Advancement of the work piece into the work zone is accomplished by the operator depressing both palm buttons PB–5 and PB–6 to provide a path of current to reach and energize relay 2CR. At the time of relay energization, a holding circuit around palm buttons PB–5 and PB–6 is established through the now closed contact 2CR–2 and power is supplied to the vacuum motor MOT–4, contact 4MR–2 in the motor circuit being closed by relay 4MR. The operator is now free to release the two spring loaded palm buttons which, in turn, provide a circuit to energize relay 3CR. Energizing relay 3CR closes contact 3CR–1.

Assuming, for explanatory purposes, that the shearing apparatus has been started with the switch actuator **122**,

locked to shaft 17 (FIG. 1), in physical contact with limit button 123 on switch LS–1, it can be seen that a path for current now exists to cause relay 4CR to become energized. Energization of relay 4CR results in contact 4CR–1 to close. Current now flows through 3CR–1, normally closed time delay contact 1TD–1, and the now closed 4CR–1 to reach and energize solenoid SOL–1. Solenoid SOL–1 is physically located in the loading head hydraulic drive unit 25 (FIGS. 1–3) and causes a delivery valve therein to direct hydraulic fluid through intake port 32 causing the loading frame to rotate in a clockwise direction. As previously explained, the loading head will be advanced in a clockwise direction until its advancement is interrupted by indexing stops 36. It should be noted at this point that as the loading head begins to swing towards the work zone, contact with limit switch LS–1 is broken, and, in fact, no contact is being made with either limit switch LS–1 or LS–2. With both LS–1 and LS–2 out of the circuit, the electromagnetic brake 58 and electromagnetic clutch 51 are deenergized thereby allowing the loading head to swing freely from one position to another. Upon the completion of the advancement of the brush into the work zone, limit switch LS–2 is physically made by the actuator 122 contacting button 124 (FIG. 1) thereby providing a path for current to reach the timer circuit. A relay built into the timer (not shown) immediately opens normally closed time delay contact 1TD–1 preventing any change in the delivery valve position in the loading head hydraulic drive unit so that the frame continues to be driven against the indexing stops by the hydraulic drive unit.

Closing switch LS–2 also allows 120-volt A.C. current to reach the full-wave bridge rectifier REC–1 which, in turn, converts the alternating current into 90 volts average D.C. current needed to energize the magnetic clutch and brake. As previously explained, energizing the magnetic clutch now couples brush motor MOT–1 to the brush being supported in the work zone. At this time the brake located in the load and unload station is also energized causing truncated cone-shaped member 11 positioned therein to be locked in a stationary position providing the operator with a non-movable surface against which he can work as well as stopping freely spinning brushes which are returned from the work zone.

Closing of limit switch LS–2 also energizes solenoid SOL–3 causing movable table 96 actuating cylinders 103 (FIG. 3) to extend, thus moving the work table, with the cutting heads affixed thereto, into the work. The table continues to move forward under the action of the cylinders until arrested by blocks 113 (FIG. 4). The circuitry will remain positioned as herein described until the timer times out. That is to say, the oscillating cutting heads are now located at a predetermined distance from the axial center line of the rapidly rotating brush and are in a position to shear the hair fibers to a uniform size. Also at this time, the cutting heads are being reciprocated in a lateral direction so that the areas being sheared by each cutting head overlap the adjacent areas to produce a smooth, even outer periphery.

It should be noted that shearing times will vary as the diameter and fabric materials vary and, therefore, it has been found advantageous to provide the apparatus of the present invention with an adjustable timer. Timers of this nature are marketed under the tradename Cycleflex by the Eagle Timer Company.

Upon termination of the time cycle, a relay in the timer circuit causes contact 1TD–2 to close and contact 1TD–3 to open. Opening contact 1TD–3 results in the electromagnetic brake and clutch to be deenergized as well as deenergizing solenoid SOL–3. With solenoid SOL–3 deenergized, spring loaded piston 107 (FIG. 4) is now able to force the table back against stop block 110 thus moving the cutters out of contact with the work.

At this ime, swich LS–2 is closed allowing relay 5CR to pull contact 5CR–1 to a closed position providing a path through 3CR–1 and the now closed contact 1TD–2 to energize solenoid SOL–2. Solenoid SOL–2 repositions previously referred to delivery valve in the loading head hydraulic drive unit so that the head swings back in a counterclockwise direction until once again indexing stops 36, mounted in embossed sections 38, interrupt the rotational movement of the head. It should be noted that as the head is rotating between stations, both limit switches LS–1 and LS–2 are opened, deenergizing he brake and clutch to permit free entry into the new position. A new or untreated brush is advanced to the work zone while a sheared or treated brush returns to the unloading position. With limit switches LS–1 and LS–2 open, the timer is also taken out of the circuit so that it will be able to reset itself preparatory to repeating the above-described indexing cycle. The automatic indexing operation will continue until such time as either switch EMS–1 is opened causing cessation of all machine operation or one of motor controlling relays is taken off the line.

While the invention has been described with reference to the structure disclosed herein, it is not confined to the details set forth, and this application is intended to cover such modificaions or changes as may come within the scope of the following claims.

What is claimed is:

1. Apparatus for sizing the individual hair fibers of a cylindrical brush including

a frame,

support means for rotatably supporting a cylindrical brush in said frame,

drive means for rotating the brush about the axis center line thereof at a speed sufficient to suspend the individual brush fibers in a radial direction,

a plurality of cutter heads having blades therein, the cutters being movably mounted in said frame and being positioned adjacent to each other in a plane parallel to the exial centerline of the brush,

means to move the cutters uniformly into contiguous tangential relation with the brush fibers,

slide means to drive the individual cutter blades substantially perpendicular to the direction of rotation of said brush at a speed sufficient to shear fibers presented thereto,

reciprocating means to move the cutter heads transversely along the brush surface wherein each cutter treats a surface of the brush previously treated by the adjacent cutter.

2. The apparatus of claim 1 wherein a vacuum drawing means is positioned adjacent to the cutters on the side of the cutters away from said brush to further support the brush fibers presented to said blades.

3. Apparatus for accurately sizing the individual hair fibers of a cylindrical brush to produce a brush having a smooth symmetrical outer periphery thereon including

a stationary base plate,

support means for rotatably supporting a cylindrical brush in said base plate,

drive means for rotating the brush about the axial centerline thereof at a speed sufficient to suspend the individual brush fibers in a radial direction,

a movable table hinged for rotation on said base plate,

a plurality of cutting heads having clipper blades therein, the heads mounted on said movable table and being positioned adjacent to each other in a plane substantially parallel to the axial centerline of a brush supported in said stationary base plate,

means to move said table about the hinge whereby the cutters are moved into contiguous and tangential relation with the brush fibers wherein the brush fibers are clipped by said blades,

reciprocating means to move the plurality of heads transversely along thhe brush surface wherein each head treats a surface of a brush previously treated by an adjacent head.

4. The apparatus of claim 3 wherein a vacuum draw-

ing means is positioned adjacent the cutters and arranged to further support the brush fibers presented to said cutters..

5. The apparatus of claim 4 having further means to control the distance through which said movable table is rotated wherein a brush having hair fibers of a predetermined length are produced therein.

References Cited

UNITED STATES PATENTS

Re. 16,204	11/1925	Ramstetter	51—53
1,389,302	8/1921	Hagstrom	300—17
2,003,269	5/1935	Arter	51—53 X
2,773,333	12/1956	Johansson	51—53
3,233,943	2/1966	Peterson	300—17
2,929,140	3/1960	Wilson	30—133
3,432,973	3/1969	Heinrich	51—215

WAYNE A. MORSE, JR., Primary Examiner

U.S. Cl. X.R.

51—53; 83—100, 215